

NWS-TDL-ON-85-10

U.S. DEPARTMENT OF COMMERCE  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION  
NATIONAL WEATHER SERVICE  
OFFICE OF SYSTEMS DEVELOPMENT  
TECHNIQUES DEVELOPMENT LABORATORY

TDL OFFICE NOTE 85-10

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AFOS-ERA VERIFICATION OF GUIDANCE AND  
LOCAL AVIATION/PUBLIC WEATHER FORECASTS--NO. 3  
(OCTOBER 1984-MARCH 1985)

Gary M. Carter, Valery J. Dagostaro, J. Paul Dallavalle, Normalee S. Foat,  
George W. Hollenbaugh, and George J. Maglaras

July 1985



**U.S. DEPARTMENT OF COMMERCE**  
**National Oceanic and Atmospheric Administration**  
NATIONAL WEATHER SERVICE  
Silver Spring, Md. 20910

September 6, 1985

W/OSD21:GMC

TO: Recipients of TDL Office Notes

THRU: W/OSD2 - Harry R. Glahn *H.R.G.*

FROM: W/OSD21 - Gary M. Carter *Gary Carter*

SUBJECT: Revision of TDL Office Note 85-10, "AFOS-era Verification of Guidance and Local Aviation/Public Weather Forecasts--No. 3 (October 1984-March 1985)"

Attached is a revised version of Fig. 2.1 for TDL Office Note 85-10 which contains corrected values of local and guidance PoP forecast improvements over climate (first and third period, 0000 GMT cycle) for the cool seasons of 1979-80, 1980-81, 1981-82, and 1982-83. The scores for the other four cool seasons (1977-78, 1978-79, 1983-84, and 1984-85) were correct as plotted originally. As shown in the revised chart, the overall skill of the local (and to a lesser extent guidance) forecasts has remained about the same during the past 8 years.

Yes, we discovered an error in the old verification system. The error involved miscalculation of some of the percent improvement over climate scores for three stations in Florida (Jacksonville, Orlando, and Tampa). Unfortunately, this error also greatly impacted the overall results for the NWS Southern Region, as well as those for all stations combined. The individual NWS Brier scores for the locals and the guidance were computed correctly, but the improvements over climate were wrong. In particular, the improvement over climate values for the 12-24 h (first period) and 36-48 h (third period) forecasts from 0000 GMT, and the 24-36 h (second period) forecasts from 1200 GMT were much too high. The magnitude of this error was about 30% for each of the three stations, 15% for the Southern Region, and 5% for the Nation.

The following is a list of the TDL reports and corresponding tables and figures for which these improvements over climate values were erroneous.

<u>TDL Office Note</u>	<u>Table</u>	<u>Figure</u>
81-3	2.2, 2.4	2.1
81-10	2.2, 2.4, 2.7, 2.9	2.1
82-11	2.2, 2.4, 2.7, 2.9	2.1
83-16	2.2, 2.4, 2.7, 2.9	2.1

Although we are not planning to distribute revisions for each individual document, we are quite willing to provide those interested with the corrected values.



I'm sorry this error occurred and affected the scores for so many years. However, all the warm season values were computed correctly. In addition, the scores produced by the new AFOS-era verification system which was implemented with the 1983-84 cool season are correct.

Attachment

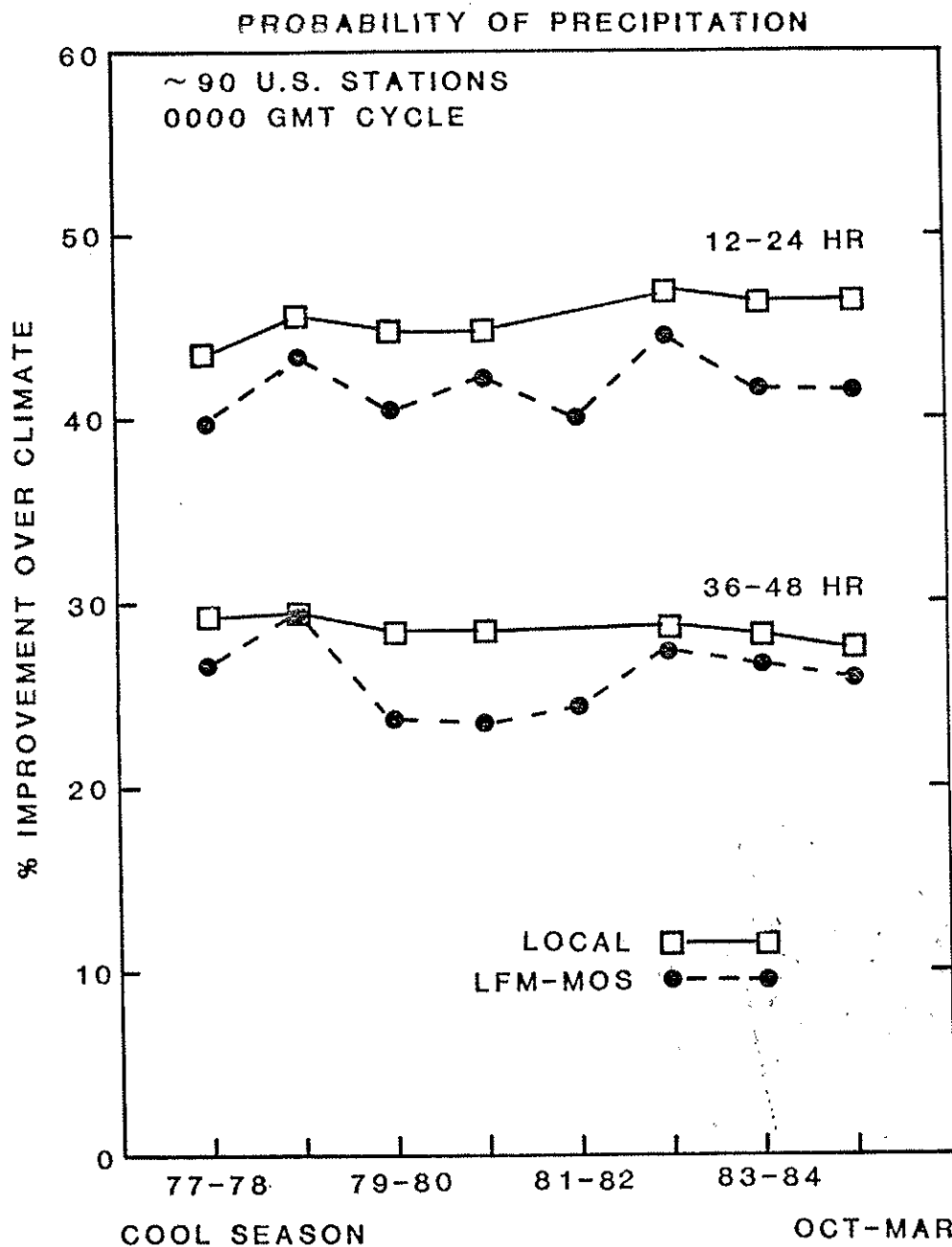


Figure 2.1. (Revised) Percent improvement over climate in the NWS Brier score of the local and guidance PoP forecasts. Results for 1981-82 local forecasts were unavailable because of missing data.

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1. INTRODUCTION

This is the third in a new series of Techniques Development Laboratory (TDL) office notes which compare the performance of TDL's automated guidance with National Weather Service (NWS) local forecasts made at Weather Service Forecast Offices (WSFO's). All of the forecasts (both local and guidance) and the verifying observations were collected locally at the WSFO's, transmitted via the Automation of Field Operations and Services (AFOS) system to the National Meteorological Center, and archived centrally by TDL. The local collection system is described by Miller et al. (1984), while guidelines for the public/aviation forecast verification program are given in National Weather Service (1983).

In this report, we present verification statistics for the cool season months of October 1984 through March 1985 for probability of precipitation (PoP), precipitation type (rain, freezing rain, or snow), surface wind, cloud amount, ceiling height, visibility, and maximum/minimum (max/min) temperature. In addition, snow amount forecast results are available for the first time. Verification summaries are provided for both forecast cycles, 0000 and 1200 GMT. The scores are those recommended in the NWS National Verification Plan (National Weather Service, 1982a).

The subjective local public weather PoP and max/min forecasts used for verification were official forecasts obtained from the Coded City Forecast (FPUS4) bulletin. Most of the local aviation weather forecasts were obtained from NWS official terminal forecasts (FT's). The precipitation type, snow amount, 42-h surface wind, and cloud amount forecasts were manually entered by the forecasters at the WSFO's. The local forecasts may or may not be based on the objective guidance. Surface observations as late as 2 hours before the first valid forecast time may have been used in preparation of the subjective forecasts.

The automated guidance was based on forecast equations developed through application of the Model Output Statistics (MOS) technique (Glahn and Lowry, 1972). In particular, the equations were derived by using archived surface observations and forecast fields from the Limited-area Fine Mesh (LFM) model (Gerrity, 1977; Newell and Deaven, 1981; National Weather Service, 1981a). The surface observations used in these equations were taken at least 9 hours before the first verification valid time.

As noted in the sections which follow for each of the various weather elements (except for PoP), implementation of the new AFOS-era verification system has introduced significant changes from past verifications in regard to the characteristics of the local forecasts and verifying observations. For example, the local and guidance max/min temperature forecasts are now being verified by using max/min temperatures observed during 12-h instead of 24-h (calendar day) periods. Also, the cloud amount observations are given in terms of

total sky cover rather than opaque sky cover. Many other changes are associated with obtaining the local forecasts from the FT's. Hence, except for the PoP forecasts, we do not think it is meaningful to compare results for the 1984-85 cool season with those based on data which were obtained prior to October 1983 from the pre-AFOS verification system (e.g., Carter et al., 1983).

## 2. PROBABILITY OF PRECIPITATION

The MOS PoP forecasts were produced by the cool season prediction equations described in Technical Procedures Bulletin No. 289 (National Weather Service, 1980). This guidance was available for the first, second, and third periods, which correspond to 12-24, 24-36, and 36-48 hours, respectively, after 0000 and 1200 GMT. The predictors for the equation development were forecast fields from the LFM model and weather elements observed at the forecast site at 0300 or 1500 GMT. However, because of time constraints in day-to-day operations, surface observations at 0200 (1400) GMT were used as input to the prediction equations about 80% (60%) of the time.

The forecasts were verified by computing Brier scores (Brier, 1950) for 93 of the 94 stations listed in Table 2.1. Please note that we used the standard NWS Brier score for PoP which is one-half the original score defined by Brier. Brier scores will vary from one station to the next and from one year to the next because of changes in the relative frequency of precipitation. In particular, the scores usually are better for periods of below normal precipitation. Therefore, we also computed the percent improvement over climate, that is, the percent improvement of Brier scores obtained from the local or guidance forecasts over analogous Brier scores produced by climatic forecasts. Climatic forecasts are defined as relative frequencies of precipitation by month and by station determined from a 15-yr sample (Jorgensen, 1967). Because local forecasters should be encouraged to depart from the guidance if they have reason to believe it is incorrect, the number of times local forecasters deviated from the guidance and the percent of these changes which were in the correct direction also were tabulated.

Tables 2.2 and 2.7 present the 1984-85 cool season results for all 93 stations combined for the 0000 and 1200 GMT cycle forecasts, respectively. Tables 2.3-2.6 and Tables 2.8-2.11 show scores for the NWS Eastern, Southern, Central, and Western Regions, for the 0000 and 1200 GMT cycles, respectively. Comparisons of the Brier scores and improvements over climate in Table 2.2 indicate the 0000 GMT cycle local forecasts were better than the guidance for all three periods. Local forecasters deviated from the guidance about 57% of the time and were correct when they did so 61%, 60%, and 55% of the time for the first, second, and third periods, respectively. At the regional level for the 0000 GMT cycle (Tables 2.3-2.6), the local forecasts for all regions and periods usually were as good as, or better than, the guidance. Table 2.7 shows that, overall, the 1200 GMT cycle local forecasts were better than the guidance for all three periods. Also, the local forecasters deviated from the 1200 GMT guidance about 58% of the time and were correct when they did so 65%, 56%, and 62% of the time for the first, second, and third periods, respectively. Regionally, for the 1200 GMT cycle (Tables 2.8-2.11), the local forecasts for all three periods were better than the guidance.

In regard to percent improvement over climate for all stations combined, the 0000 GMT cycle second- and third-period local and guidance scores were slightly worse than those for the previous cool season of 1983-84 (Carter et al., 1984). The results for the first-period forecasts were the same as those for 1983-84. For the 1200 GMT cycle, the 1984-85 scores were worse than those for the previous cool season for all three forecast periods. This decline in skill is also shown in Fig. 2.1 which depicts the trend in the percent improvement over climate scores for the 0000 GMT cycle local and LFM-based guidance forecasts for the first and third periods. Please note that the cool season of 1977-78 marks the start of the period when a complete, LFM-based MOS package was available for use as guidance by NWS field forecasters. The plot shows that since the 1979-80 cool season when local and guidance forecasts were the most skillful, there has been an overall decline for both the local and guidance forecasts.

### 3. PRECIPITATION TYPE

The objective conditional probability of precipitation type (PoPT) forecast system described in Technical Procedures Bulletin No. 319 (National Weather Service, 1982c) and Bocchieri and Maglaras (1983) provides categorical forecasts for three categories: frozen (snow or ice pellets), freezing (freezing rain or drizzle), and liquid (rain). Precipitation in the form of mixed snow and ice pellets is included in the frozen category; any mixed precipitation type which includes freezing rain or drizzle is included in the freezing category; all other mixed precipitation types are included in the liquid category. In this report, the frozen, freezing, and liquid categories will be referred to as snow, freezing rain, and rain, respectively.

For verification purposes, local categorical forecasts of precipitation type are given for the 18-, 30-, and 42-h projections from 0000 and 1200 GMT. Note, this is a conditional forecast, that is, it's a forecast of the type of precipitation if precipitation actually occurs. Therefore, a precipitation type forecast is always recorded. Similarly, the PoPT guidance is conditional and is available whether or not precipitation occurs.

Table 3.1 lists the 86 stations used for the precipitation type verification. The verification sample included only those cases in which precipitation actually occurred within  $\pm 1$  hour of the forecast valid time. If a combination of precipitation types occurred during the 2-h period, the verifying observation was considered as freezing if freezing precipitation was observed at any time, or frozen if frozen (but not freezing) precipitation occurred. Also, since we were concerned that some forecasters may not have put much effort into making the conditional forecasts when they considered precipitation to be unlikely, we used cases only when the local PoP was  $\geq 30\%$ . The PoP forecasts were valid for 12-h periods centered on the 18-, 30-, and 42-h projections from both 0000 and 1200 GMT.

Tables 3.2 and 3.3 show the contingency tables for the three categories of precipitation type for the local and guidance forecasts for the 18-, 30-, and 42-h projections from 0000 and 1200 GMT, respectively. From these tables, bias

by category,<sup>1</sup> probability of detection (POD),<sup>2</sup> false alarm ratio (FAR),<sup>3</sup> skill score,<sup>4</sup> and percent correct were calculated. Tables 3.4 and 3.5 show the verification results for 0000 and 1200 GMT, respectively. For the 0000 GMT cycle (Table 3.4), the results in terms of percent correct and skill score for all stations combined indicate that the guidance was better than the local forecasts for all three projections. This is a reversal from the results for the previous cool season. In terms of bias by category, POD, and FAR, the comparisons varied from projection to projection, but the overall quality of the guidance was better than that of the local forecasts. The 1200 GMT verification results for all stations combined (Table 3.5) indicate that, in terms of percent correct and skill score, the guidance was better than the local forecasts for all three projections. In terms of bias by category, POD, and FAR, the accuracy of the local and guidance forecasts was about the same overall.

The number of freezing rain cases is small, and conclusions for that category must be drawn with caution. In general, for both cycles, the guidance over-forecast freezing rain (bias > 1.0) and in all except one of the six comparisons forecast more freezing rain events than did the local forecasters. As might be expected then, the POD for guidance was usually higher (better) than that for the local forecasts. The FAR was also generally higher (worse) for guidance. These conclusions are consistent with those for the previous cool season.

#### 4. SNOW AMOUNT

The objective probability of snow amount forecast system described in Technical Procedures Bulletin No. 318 (National Weather Service, 1982b) provides categorical forecasts for four categories of snow amount: < 2, 2 or 3, 4 or 5, and  $\geq 6$  inches. Forecast equations based on LFM model fields are used to produce conditional probabilities of snow amount for the three categories of  $\geq 2$ ,  $\geq 4$ , and  $\geq 6$  inches. These conditional probabilities are converted to unconditional probability forecasts through the use of MOS PoP and probability of frozen precipitation forecasts. The unconditional probability forecasts are converted to categorical forecasts, for the four categories mentioned above, through the use of the threshold technique described in Technical Procedures Bulletin No. 318.

Verification scores were computed for both local and guidance forecasts for 83 of the 86 stations listed in Table 3.1. The local and guidance forecasts

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<sup>1</sup>In the discussion of precipitation type, snow amount, surface wind, cloud amount, ceiling height, and visibility, bias by category refers to the number of forecasts of a particular category (event) divided by the number of observations of that category. A value of 1.0 denotes unbiased forecasts for a particular category.

<sup>2</sup>The POD is the ratio of the number of times a particular category was correctly forecast to the total number of observations of that category.

<sup>3</sup>The FAR is the ratio of the number of times a particular category was incorrectly forecast to the total number of forecasts of that category.

<sup>4</sup>The skill score used throughout this report is the Heidke skill score (Panofsky and Brier, 1965).

were verified for the 12-24 h period from both 0000 and 1200 GMT, since the guidance was provided for this projection only.

We constructed forecast-observed contingency tables for four categories of snow amount. These tables were used for computing several different scores: bias by category, percent correct, skill score, threat score,<sup>5</sup> POD, and FAR. The percent correct and skill score were calculated based on all four categories combined. The bias by category, threat score, POD and FAR were calculated separately for the three cumulative categories of  $\geq 2$ ,  $\geq 4$ , and  $\geq 6$  inches. We have summarized the results in Tables 4.1-4.3.

Tables 4.1 and 4.2 show the contingency tables for 0000 and 1200 GMT, respectively. Table 4.3 shows comparative verification scores for snow amount forecasts for both cycles. In terms of percent correct and skill score for all stations combined, the quality of the guidance and the locals was about the same. In terms of bias by category, threat score, POD, and FAR, the comparisons between local and guidance forecasts varied from score to score and cycle to cycle but, in general, the guidance was better than the local forecasts for the  $\geq 2$  and  $\geq 4$  inch categories, while the local forecasts were better than the guidance for the  $\geq 6$  inch category. Also, for most of the scores, both the local and guidance forecasts performed substantially better for the 1200 GMT cycle than for the 0000 GMT cycle. This may be related to the fact that there were considerably more cases of snow reported during 1200 GMT forecast cycle.

## 5. SURFACE WIND

The objective surface wind forecasts were generated by the cool season, LFM-based equations described in Technical Procedures Bulletin No. 347 (National Weather Service, 1984b). Prior to the 1983-84 cool season, the surface wind prediction equations were rederived in order to account for the most recent data available from the LFM model. The objective surface wind forecast is defined in the same way as the observed wind, namely, the 1-min average wind direction and speed for a specific time. All objective forecasts of wind speed were adjusted by an "inflation" technique (Klein et al., 1959) involving the multiple correlation coefficient and the mean value of wind speed for each particular station and forecast valid time.

The local forecasts were obtained from the FT's (except those for the 42-h projection which are discussed later). Since the FT's do not mention wind if the speed is expected to be less than 10 kt, the wind forecasts were verified in two ways. First, for those cases in which the speed forecasts from both the FT and MOS were  $\geq 10$  kt, the mean absolute error (MAE) and the mean algebraic error of the speed forecasts were computed. Cases where the observed wind was calm were then eliminated from this sample and the MAE of direction was computed. Second, for all cases where both the FT's and the MOS forecasts were available, the skill score, percent correct, bias by category, and threat score were computed from contingency tables of wind speed. The definitions of the

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<sup>5</sup>Threat score =  $H/(F+O-H)$ , where H is the number of correct forecasts of a category, and F and O are the number of forecasts and observations of that category, respectively.

categories used in the contingency tables are given in Table 5.1. The threat score used here was calculated by combining events of the upper two categories ( $> 27$  kt). In addition, for all cases in which the wind speeds (forecasts or corresponding observations) were at least 10 kt, the skill score for the wind direction forecasts was computed from contingency tables (see Table 5.1 for the category definitions). The 94 stations used in the verification are listed in Table 2.1.

We verified the 12-, 18-, and 24-h forecasts from both 0000 and 1200 GMT. It is important to note that several fundamental differences exist between the MOS forecasts and the local forecasts obtained from the FT's. In particular, the FT's are not as precise in regard to valid time as are the objective forecasts. Another point that must be considered is the nature of the wind forecast in the FT. It is unclear whether aviation forecasters tend to concentrate on a specific extreme wind or on an average wind over the forecast period. In this respect, an additional comparison was made between the objective and local forecasts by using the highest observed sustained wind within  $\pm 3$  hours surrounding the verification time. Since the results were similar to those based on the single observation at the verification time, they are not presented here. Due to these and other possible differences between the MOS forecasts and local forecasts as obtained from the FT's, only conclusions of a general nature should be drawn from these verification statistics.

The results for all 93 (94) stations combined for the 0000 (1200) GMT cycle are presented in Tables 5.2-5.4 (Tables 5.9-5.11). The direction MAE's and skill scores for the 0000 and 1200 GMT cycles, as given in Tables 5.2 and 5.9, respectively, show that the local forecasters were superior to the guidance for the 12-h projection. In contrast, for the 18- and 24-h projections, the guidance was better than the locals and by a large margin. The speed MAE's indicate there was little difference between guidance and locals, except the guidance was better at the 24-h projection. The skill scores and percents correct for speed show that the guidance was better than the locals for the 18- and 24-h projections. In terms of the mean algebraic errors, both types of forecasts overestimated the 1-min average winds by about 1 kt. The speed bias by category in Tables 5.2 and 5.9 and the contingency tables in Tables 5.4 and 5.11 show that for both cycles, the guidance and locals generally underestimated winds stronger than 22 kt (i.e., categories 4, 5, and 6) for all projections. In terms of the threat scores for winds  $> 27$  kt (i.e., categories 5 and 6 combined), the locals were better than the guidance for both the 12- and 18-h projections.

For the cool seasons of 1981-82 through 1983-84, the MOS guidance exhibited a tendency to overestimate winds  $\geq 18$  kt. We suspect that this underforecasting of strong winds during 1984-85 is related to the recent changes in the LFM model. On January 10, 1985, the surface stress profile was modified in the operational version of the LFM model (National Weather Service, 1985). This was done in an attempt to reduce the LFM model's tendency to deepen cyclones excessively and move them too far south. Of course, if the surface stress modification was effective in removing this systematic bias from the model forecasts, the corresponding MOS surface wind guidance probably would be impacted substantially. In order to better assess the impact of the LFM's new surface stress profile, we stratified the MOS wind speed results according to the date that the modification was introduced. Fig. 5.1 shows the bias values for winds

> 18 kt for the 18-h forecasts from 0000 GMT. The results indicate that the biases for all stations combined, as well as those for each region (especially the Central and Western), dropped significantly after January 9, 1985. Hence, it appears that the underforecasting of strong winds by the guidance is directly related to changes in the operational version of the LFM model.

Tables 5.5-5.8 and 5.12-5.15 show scores for the NWS Eastern, Southern, Central, and Western Regions for 0000 and 1200 GMT, respectively. The regional comparisons have the same general characteristics as were noted for the entire group of stations. Of course, for some scores, the comparisons differ from region to region.

Longer range (42-h) forecasts of winds > 22 knots also were collected as part of the AFOS-era verification system. The local forecasts were manually entered by forecasters at the WSFO's. Since these forecasts specify the occurrence (or non-occurrence) of an operationally significant wind, they were verified against the highest observed sustained wind within  $\pm 3$  hours surrounding the forecast valid time. For purposes of comparison, and analogous to the development of the MOS prediction equations, another set of scores also were calculated by using the 1-min average wind at the forecast valid time as the verifying observation.

Comparative verification results for the 0000 and 1200 GMT cycle 42-h wind speed forecasts are presented in Tables 5.16 and 5.17, respectively. The results for each type of verifying observation are shown only for all 94 stations combined because there were not enough forecasts of wind > 22 kt to provide meaningful comparisons at the regional level. Overall, the scores (skill score, percent correct, threat score, and bias by category) for both cycles indicate that usually the guidance was superior to the local forecasts for the 1-min average speed observation comparisons. In contrast, the locals were much better than the guidance for the  $\pm 3$ -h maximum sustained wind verifications except for percent correct. This is not surprising, since the MOS equations were developed with 1-min average winds at specific times, while the local forecasters are more concerned with the likelihood of a significant wind occurrence over a longer time interval.

## 6. CLOUD AMOUNT

During the 1984-85 cool season, the objective cloud amount forecasts were produced by the prediction equations described in Technical Procedures Bulletin No. 303 (National Weather Service, 1981b). These regional, generalized-operator equations make use of LFM model output and 0200 (1400) GMT surface observations to produce probability forecasts of the four categories of cloud amount. We convert the probability estimates to "best category" forecasts in a manner which produce good bias characteristics, that is, a bias value of approximately 1.0 for each category. The threshold technique described in Technical Procedures Bulletin No. 303 was used to obtain the best category forecasts.

We compared the local forecasts with a matched sample of guidance for the 94 stations listed in Table 2.1 for the 12-, 18-, and 24-h projections from 0000 and 1200 GMT. The local forecasts and surface observations used for verification were converted to the cloud amount categories given in Table 6.1.

Four-category (clear, scattered, broken, and overcast), forecast-observed contingency tables were prepared from the local and objective categorical predictions. Using these tables, we computed the percent correct, skill score, and bias by category. In past verifications (except for the 1983-84 cool season and the 1984 warm season), only opaque sky cover amounts from surface observations were used in determining the observed categories. However, the hourly surface reports from which the verifying observations are now being used do not include total opaque sky cover as part of the observation; hence, thin clouds are also taken into account. For example, an observation of eight tenths opaque and two tenths thin is categorized as overcast since at least half of the reported sky cover was opaque. However, with the previous verification system, this report was put into the broken category because only the opaque sky cover would be used. The result of this change is to decrease (increase) the number of observations of the broken (overcast) category compared to previous verifications. This change has greatly affected the overall bias by category statistics for the guidance and local forecasts.

The results for all stations combined are shown in Tables 6.2 and 6.7 for the 0000 and 1200 GMT cycle forecasts, respectively. In terms of skill score and percent correct for both cycles, the local forecasts were better than the guidance for the 12-h projection but were worse than the guidance for the 18- and 24-h projections. Examination of the bias by category results indicates the guidance was better (i.e., closer to 1.0) than the locals for most projections and categories. The biases for the broken category for both local and guidance forecasts were extremely poor; of course, this is related in part to the changes in the verification process which were mentioned before. In comparison with the overall results for the previous cool season (Carter et al., 1984), most of the 1984-85 scores for the three projections from 0000 and 1200 GMT were slightly worse for both the guidance and locals.

Tables 6.3-6.6 and Tables 6.8-6.11 present scores for the NWS Eastern, Southern, Central, and Western Regions, for the 0000 and 1200 GMT cycles, respectively. For both cycles, the comparisons varied considerably from region to region and from score to score.

## 7. CEILING AND VISIBILITY

During the 1984-85 cool season, the ceiling and visibility guidance was produced by the prediction equations described in Technical Procedures Bulletin No. 303 (National Weather Service, 1981b). Operationally, the guidance was based primarily on LFM model output and 0200 (1400) GMT surface observations.

Verification scores were computed for both local and guidance forecasts for the 94 stations (only 93 stations for 0000 GMT) listed in Table 2.1. The local forecasts were obtained from the FT's. Persistence based on an observation taken at 0900 (2100) GMT for the 0000 (1200) GMT forecast cycle was used as a standard of comparison. The objective forecasts were verified for both cycles for 12-, 18-, and 24-h projections. The local and persistence forecasts were verified for 12-, 15-, 18-, and 24-h projections from 0000 and 1200 GMT. On station, the guidance and persistence observations usually were available in time for preparation of the local forecasts. As was the case for surface wind, the local ceiling and visibility forecasts from the FT's are not given for a specific valid time. Hence, any comparisons with the results for the objective forecasts must be of a very general nature.

We constructed forecast-observed contingency tables for the four categories of ceiling and visibility given in Table 7.1. These categories were used for computing several different scores: bias by category, percent correct, skill score, and log score.<sup>6</sup> We have summarized the results in Tables 7.2-7.5. It should be noted that the persistence and local forecasts for the 12-, 15-, 18-, and 24-h projections are actually 3-, 6-, 9-, and 15-h forecasts, respectively, from the latest available surface observation. In this sense, the guidance for the 12-, 18-, and 24-h projections are actually 10-, 16-, and 22-h forecasts.

Tables 7.2 and 7.4 show the scores for the ceiling forecasts from 0000 and 1200 GMT, respectively. In terms of log score, skill score, and percent correct, the 0000 GMT cycle local forecasts were about as good as, or better than, persistence for all four projections; the locals were better than the guidance for the 12- and 18-h projections (guidance forecasts are not produced for the 15-h projection). The guidance was better than the locals at 24 hours in terms of percent correct and skill score. Also, the guidance was better than persistence in terms of all three scores for the 18- and 24-h projections. The 1200 GMT cycle comparisons (Table 7.4) among the three types of forecasts indicate that, for log score, skill score, and percent correct, the local forecasts were better than persistence and the guidance for all projections. The guidance was better than persistence only for percent correct and skill score for the 24-h projection.

Tables 7.3 and 7.5 show the scores for the visibility forecasts for the 0000 and 1200 GMT cycles, respectively. In terms of log score, percent correct, and skill score, the 0000 GMT cycle local forecasts of visibility were about as good as, or better than, persistence for the 15-, 18-, and 24-h projections and better than the guidance for all projections. The guidance was better than persistence for the 18- and 24-h projections. Overall, persistence provided the best forecasts for the 12-h projection. The 1200 GMT cycle results (Table 7.5) varied considerably from projection to projection and from one forecast type to another. In general, the local forecasts were better than persistence, and both types of forecasts were better than the guidance.

Overall, for ceiling and visibility, for both forecast cycles, and for all three types of forecasts, all of the 1984-85 scores except for skill score were slightly but consistently better than those for the previous cool season (Carter et al., 1984).

## 8. MAXIMUM/MINIMUM TEMPERATURE

The max/min temperature guidance for the 1984-85 cool season was generated by the LFM-based regression equations described in Technical Procedures Bulletin No. 344 (National Weather Service, 1984a). The equations were developed by stratifying archived LFM model forecasts, station observations, and the first two harmonics of the day of the year into seasons of 3-mo duration (Dallavalle et al., 1980). We defined fall as September-November, winter as

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<sup>6</sup>This is proportional to the absolute value of  $\log_{10}f_i - \log_{10}O_i$ , where  $f_i$  is the forecast category for each case and  $O_i$  is the observed category for each case. The result is averaged over all cases and scaled by multiplying by 50.

December-February, and spring as March-May. The MOS guidance is valid for the local calendar day. The first period (approximately 24-h) objective forecast of the max based on 0000 GMT model data is for the calendar day starting at the subsequent midnight. The max/min guidance for the other periods (projections of approximately 36, 48, and 60 hours) also corresponds to specific calendar days.

In contrast, the subjective local forecasts are for the daytime max and the nighttime min. Thus, the first period subjective max forecast from 0000 GMT data is for today's high. The second period forecast is for tonight's low and so forth. A similar procedure is followed for the 1200 GMT cycle, except that the first period is tonight's min. For the local forecast, daytime is defined to be approximately from 1200 to 0000 GMT. Nighttime then extends from 0000 to 1200 GMT except in the western parts of the Central and Southern Regions and throughout the entire Western Region where nighttime may go to nearly 1800 GMT.

In this report, we present results for both objective guidance and subjective local forecasts which were verified by using observations approximating the daytime high or nighttime low. Note that the max/min observations given in the synoptic or hourly codes do not correspond exactly to the daytime or nighttime periods. Thus, while the min temperature reported at 1200 GMT is valid for the preceding 12-h period, this observation inadequately represents the overnight low. Even in the eastern United States during the winter, the low often occurs around sunrise and after 1200 GMT. This problem is obviously exacerbated in the western United States where 1200 GMT corresponds to 0400 LST, a time preceding the normal occurrence of the overnight low. On the other hand, the 0000 GMT report of the max temperature, valid for the previous 12 hours, is a reasonable indicator of the daytime high.

To overcome these difficulties with the max/min observations, a new procedure for deducing the daytime high and nighttime low from synoptic and hourly reports was implemented at the beginning of the 1984-85 cool season. In the local AFOS-era verification software (Miller et al., 1984), daytime is defined as 0700-1900 LST and nighttime as 1900-0800 LST. The local program scans the synoptic and hourly reports to determine if the synoptic report adequately represents the nighttime or daytime period. If such a report is available, this observation is used. On the other hand, if the synoptic report is not representative of the appropriate period, then an algorithm is used to deduce an appropriate value from available synoptic and hourly temperature observations. Also, the local forecaster is provided the option of replacing the calculated observation with the exact nighttime low or daytime high. It's important to note, then, that the observations used for verification in this report correspond to the local forecast times and not to the calendar day periods for which the objective guidance is valid.

We verified the local and MOS max/min temperature forecasts for both the 0000 and 1200 GMT cycles. The mean algebraic error (forecast minus observed temperature), mean absolute error, the number of absolute errors  $> 10^{\circ}\text{F}$ , the conditional probability of detection<sup>7</sup> of min temperatures  $\leq 32^{\circ}\text{F}$ , and the

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<sup>7</sup>Here, the conditional probability of detection is defined to be the fraction of time the min temperature was correctly forecast to be  $\leq 32^{\circ}\text{F}$  when the previous day's min was  $\geq 40^{\circ}\text{F}$ .

conditional false alarm ratio<sup>8</sup> for min temperatures  $\leq 32^{\circ}\text{F}$  were computed for 93 stations in the conterminous United States (see Table 2.1). At 0000 (1200) GMT, the local max temperature forecasts are valid for daytime periods ending approximately 24 (36) and 48 (60) hours after 0000 (1200) GMT. Similarly, at 0000 (1200) GMT, the local min temperature forecasts are valid for nighttime periods ending approximately 36 (24) and 60 (48) hours after 0000 (1200) GMT.

For all stations combined, the results for 0000 and 1200 GMT are shown in Tables 8.1 and 8.6, respectively. A matched sample of approximately 14,500 cases per forecast projection was available. Tables 8.2-8.5 give the 0000 GMT verification scores for the Eastern, Southern, Central, and Western Regions, respectively. Tables 8.7-8.10 show analogous scores by NWS region for the 1200 GMT cycle.

For all regions, both forecast cycles, and all projections, the local and MOS min temperature forecasts exhibited a pronounced cold bias (negative algebraic error). Tables 8.1 and 8.6 show for all stations combined that the bias in the MOS min forecasts ranged from  $-2.3^{\circ}\text{F}$  for tonight's min (0000 GMT) to  $-2.6^{\circ}\text{F}$  for tomorrow night's min (0000 GMT). For the local forecasts, the biases for the same projections were  $-0.7^{\circ}\text{F}$  and  $-1.6^{\circ}\text{F}$ , respectively. Although the cold bias in the min forecasts was persistent from region to region, the negative algebraic errors of both the guidance and local forecasts were greatest in the Central Region. Verifications made from the calendar day observations (not shown in this report) clearly indicate that a significant proportion of the cold bias in the objective guidance is an observational, and not a meteorological, phenomenon. In fact, the bias was reduced by 50% or more when calendar day values were used to verify the objective guidance.

Note, too, from Tables 8.1 and 8.6 that large mean absolute errors were associated with the large algebraic errors. For the four min projections and all stations combined, the mean absolute errors of the local forecasts were better than those for the MOS guidance by approximately  $0.9^{\circ}\text{F}$ . For these same projections, the guidance had a much higher percentage of forecasts with absolute errors greater than  $10^{\circ}\text{F}$  than did the local forecasts. Part of this difference between the local forecasts and the objective guidance occurs because the forecasters are able to improve upon the MOS predictions; however, a large portion is due to the verifying observation. When verified against calendar day min reports (not shown), the objective guidance improved by an average of  $0.5^{\circ}\text{F}$  mean absolute error for all periods and stations combined.

The biases for the max guidance tended to be much smaller than those for the min forecasts. For nearly all regions and all max forecast projections, the MOS forecasts had a warm bias (positive algebraic error). In contrast, the biases of the local forecasts were small and tended to vary in sign among regions and projections. As with the min forecasts, most of the bias in the max temperature guidance was due to the verifying observation used. For all regions and all projections combined, the local max temperature forecasts were about  $0.4^{\circ}\text{F}$  more accurate than the guidance in terms of mean absolute error.

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<sup>8</sup>Here, the conditional false alarm ratio is defined to be the fraction of forecasts of  $\leq 32^{\circ}\text{F}$  that failed to verify when the previous day's min was  $\geq 40^{\circ}\text{F}$ .

Comparisons of this cool season's verifications with the 1983-84 scores (Carter et al, 1984) show an overall improvement in both the local and MOS forecasts of approximately 0.1°F mean absolute error. Also, the verifications in Tables 8.1 and 8.6 indicate that for approximately similar projections the min temperature was more difficult to predict than the max. As an example, the mean absolute error for the 24-h projection of the min (tonight's min) from 1200 GMT was 3.6°F and 4.8°F for the local forecasts and the guidance, respectively. For the 24-h projection of the max (today's max) from 0000 GMT, the corresponding errors were 3.2°F and 3.8°F for the local forecasts and the guidance, respectively. For all four projections combined, the absolute error of the local and MOS min forecasts averaged 0.3°F and 0.9°F, respectively, more than the max forecasts. This trend in the relative difficulty of forecasting the max or min was pronounced in the scores for all projections in the Eastern, Central, and Western Regions. During the cool season, the min is usually more difficult to forecast than the max because of the greater variability of min temperatures. The difference in predictability is likely due to the effects of mesoscale phenomena on nighttime cooling. Factors such as drainage winds, soil moisture, stratus, and snow cover influence the minimum temperature. Clearly, both the guidance and the local forecasters often have difficulties in resolving these factors.

We think that the local forecaster would be provided with more useful guidance if the MOS forecasts were valid for daytime highs and nighttime lows instead of the calendar day values. Recent work in TDL indicates that over the conterminous United States approximately 10% of the calendar day maxima during the cool season occur at night rather than during the day. More importantly, nearly 25% of the calendar day minima occur on the second evening, instead of the first. It appears from these values that the MOS guidance would be improved significantly if the valid period were changed. We are, in fact, currently deriving new equations that will predict the nighttime low and the daytime high. This new system will be implemented in the fall of 1985 and should provide the forecasters with better guidance.

## 9. SUMMARY

Highlights of the 1984-85 cool season verification results, summarized by general type of weather element, are:

- o Probability of Precipitation - The PoP verification involved 93 stations and forecast projections of 12-24, 24-36, and 36-48 hours from 0000 and 1200 GMT. The NWS Brier scores for all stations combined indicate the local forecasts were better than the guidance for all three periods for both cycles and the percent improvement ranged from 1.6% to 7.9%. Depending on the projection and cycle, the local forecasts deviated from the guidance more than 55% of the time, and these changes were in the correct direction from 55% to 65% of the time. In terms of percent improvement over climate, the 1984-85 overall scores for both the guidance and local forecasts were slightly worse than those for the previous cool season (1983-84).
- o Precipitation Type - Local and guidance forecasts for 86 stations and projections of 18, 30, and 42 hours from 0000 and 1200 GMT comprised the comparative verification. Only those cases for which the local

PoP was  $\geq 30\%$  were verified, and surface observations within  $\pm 1$  hour of the forecast valid time were used. In regard to percent correct and skill score based on 3-category (freezing rain, snow, rain) contingency tables, the results for all stations combined indicate the guidance was better than the local forecasts for all three projections and both cycles. In terms of bias by category, false alarm ratio, and probability of detection, the scores varied from projection to projection, but, overall, the guidance was better than the local forecasts.

- o Snow Amount - The snow amount verification involved 83 stations for the 12-24 h period from 0000 and 1200 GMT. In terms of bias by category, threat score, probability of detection, and false alarm ratio, the guidance was better for the  $\geq 2$  and  $\geq 4$  inch categories, but the local forecasts were better for the  $\geq 6$  inch category. Also, the 1200 GMT cycle local and guidance forecasts of snow amount were substantially better than those for 0000 GMT.
- o Surface Wind - The AFOS-era wind verification involved the comparison of surface wind speed and direction forecasts for 93 (94) stations for projections of 12, 18, and 24 hours from 0000 (1200) GMT. In this system, the local forecasts were obtained from NWS official terminal forecasts. Several fundamental differences exist between the MOS wind forecasts and those in the FT's. For example, the FT's are not as precise in regard to valid time as are the objective forecasts. Due to these differences, only conclusions of a general nature can be drawn from the results. The statistics for all stations combined for wind direction indicate the locals were able to improve upon MOS for the 12-h forecast projection from both cycles. On the other hand, guidance for the 18- and 24-h projections (both cycles) was superior to the locals. Again, the overall results for the speed forecasts indicate that the locals were generally better than guidance for the 12-h projection only. In contrast to the results for previous years, the bias by category scores showed for all projections and both forecast cycles that the guidance underforecast winds  $\geq 18$  kt. We suspect that this drastic change in the characteristics of the MOS speed forecasts is related to the recent surface stress modification which was incorporated into the operational version of the LFM model.

For the first time, a sufficient sample existed for all stations combined to verify local and guidance significant wind speed forecasts for projections of 42 hours from 0000 and 1200 GMT. These yes/no predictions of speeds  $> 22$  kt were verified in two ways: (a) against the actual 1-min average speed observation at the forecast valid time, and (b) against the maximum sustained wind within  $\pm 3$  hours of the forecast valid time. The results showed that the local scores were much better when verified against maximum sustained winds, while the MOS forecasts were superior when 1-min average speeds observed at the valid time were used.

- o Cloud Amount - The verification for cloud amount involved 94 stations and forecasts for projections of 12, 18, and 24 hours from 0000 and 1200 GMT. The skill scores and percent correct for all stations combined indicate the local forecasts were better for the 12-h projection, while guidance was better for the 18- and 24-h projections. In terms of bias by category (clear, scattered, broken, and overcast), the guidance was better than the local forecasts for most projections and categories. Overall, the scores for both the guidance and local forecasts were slightly worse than those for the 1983-84 cool season.
  
- o Ceiling and Visibility - The verification involved the comparison of local forecasts, MOS guidance, and persistence for 93 (94) stations for projections of 12, 15, 18, and 24 hours from 0000 (1200) GMT. Direct comparison of local, MOS, and persistence forecasts was possible for the 12-, 18-, and 24-h projections. These are actually 3-, 9-, and 15-h forecasts from the latest available surface observations for the locals and persistence, and in this sense, they are 10-, 16-, and 22-h projections for the guidance. The overall results for both forecast cycles for ceiling indicate that in terms of percent correct, skill score, and log score, the local forecasts were as good as, or better than, persistence and guidance for all projections; guidance was better than persistence for the 18- and 24-h projection from 0000 GMT, and for both cycles for the 24-h projection. For visibility, the percents correct, skill scores, and log scores varied considerably from projection to projection and cycle to cycle; however, in general, persistence was the best for the 12-h projection, while the local forecasts were the best for the 18- and 24-h projections. Overall, the ceiling and visibility scores for all three types of forecasts improved slightly when compared to those for the previous cool season.
  
- o Maximum/Minimum Temperature - Objective and local forecasts were verified for 93 stations for both the 0000 and 1200 GMT cycles. At 0000 (1200) GMT, the local maximum temperature forecasts were valid for daytime periods approximately 24 (36) and 48 (60) hours in advance, while the minimum temperature forecasts were valid for nighttime periods ending approximately 36 (24) and 60 (48) hours after the initial model time. In contrast, the MOS guidance was valid for calendar day periods. The max or min temperatures for daytime (0700-1900 LST) or nighttime (1900-0800 LST) periods were used as the verifying observations. These observations were deduced from synoptic and hourly reports by the local AFOS-era verification software. For all stations and projections combined, we found the mean absolute error of the local min (max) temperature forecasts averaged 0.9°F (0.4°F) less than that for the MOS guidance. Clearly, the local forecasters are making substantial improvements to the guidance; however, some of the advantage is associated with the differences between the valid periods of the two types of forecasts. Comparison of these results with the 1983-84 cool season scores revealed an overall improvement in both the locals and guidance of about 0.1°F mean absolute error.

## 10. ACKNOWLEDGMENTS

We are grateful to Fred Marshall and Eston Pennington for assistance in archiving the data, and also to Belinda Howard for typing the text and the many tables shown in this report.

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Table 2.1. Ninety-four stations used for comparative verification of MOS guidance and local probability of precipitation, surface wind, cloud amount, ceiling height, visibility, and max/min temperature forecasts. Exceptions are that LAX was not included in the PoP and max/min temperature verifications, and TCC was not available during the 0000 GMT cycle for the 12-, 18-, and 24-h forecasts of surface wind, ceiling height, and visibility.

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DCA	Washington, D.C.	ORF	Norfolk, Virginia
PWM	Portland, Maine	CON	Concord, New Hampshire
BOS	Boston, Massachusetts	PVD	Providence, Rhode Island
ALB	Albany, New York	BTU	Burlington, Vermont
BUF	Buffalo, New York	SYR	Syracuse, New York
LGA	New York (LaGuardia), New York	EWR	Newark, New Jersey
RDU	Raleigh-Durham, North Carolina	CLT	Charlotte, North Carolina
CLE	Cleveland, Ohio	CMH	Columbus, Ohio
PHL	Philadelphia, Pennsylvania	AVP	Scranton, Pennsylvania
PIT	Pittsburgh, Pennsylvania	ERI	Erie, Pennsylvania
CAE	Columbia, South Carolina	CHS	Charleston, South Carolina
CRW	Charleston, West Virginia	BKW	Beckley, West Virginia
BHM	Birmingham, Alabama	MOB	Mobile, Alabama
LIT	Little Rock, Arkansas	FSM	Fort Smith, Arkansas
MIA	Miami, Florida	TPA	Tampa, Florida
ATL	Atlanta, Georgia	SAV	Savannah, Georgia
MSY	New Orleans, Louisiana	SHV	Shreveport, Louisiana
JAN	Jackson, Mississippi	MEI	Meridian, Mississippi
ABQ	Albuquerque, New Mexico	TCC	Tucumcari, New Mexico
OKC	Oklahoma City, Oklahoma	TUL	Tulsa, Oklahoma
MEM	Memphis, Tennessee	BNA	Nashville, Tennessee
DFW	Dallas-Ft. Worth, Texas	ABI	Abilene, Texas
LBB	Lubbock, Texas	ELP	El Paso, Texas
SAT	San Antonio, Texas	IAH	Houston, Texas
DEN	Denver, Colorado	GJT	Grand Junction, Colorado
ORD	Chicago (O'Hare), Illinois	SPI	Springfield, Illinois
IND	Indianapolis, Indiana	SBN	South Bend, Indiana
DSM	Des Moines, Iowa	ALO	Waterloo, Iowa
TOP	Topeka, Kansas	ICT	Wichita, Kansas
SDF	Louisville, Kentucky	LEX	Lexington, Kentucky
DTW	Detroit, Michigan	GRR	Grand Rapids, Michigan
MSP	Minneapolis, Minnesota	DLH	Duluth, Minnesota
STL	St. Louis, Missouri	MCI	Kansas City, Missouri
OMA	Omaha, Nebraska	LBF	North Platte, Nebraska
BIS	Bismarck, North Dakota	FAR	Fargo, North Dakota
FSD	Sioux Falls, South Dakota	RAP	Rapid City, South Dakota
MKE	Milwaukee, Wisconsin	MSN	Madison, Wisconsin
CYS	Cheyenne, Wyoming	CPR	Casper, Wyoming
PHX	Phoenix, Arizona	TUS	Tucson, Arizona
LAX	Los Angeles, California	SAN	San Diego, California
SFO	San Francisco, California	FAT	Fresno, California
BOI	Boise, Idaho	PIH	Pocatello, Idaho
GTF	Great Falls, Montana	HLN	Helena, Montana
RNO	Reno, Nevada	LAS	Las Vegas, Nevada
PDX	Portland, Oregon	MFR	Medford, Oregon
SLC	Salt Lake City, Utah	CDC	Cedar City, Utah
SEA	Seattle-Tacoma, Washington	GEG	Spokane, Washington

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Table 2.2. Comparative verification of MOS guidance and local PoP forecasts for 93 stations, 0000 GMT cycle.

Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	No. of Changes to Guid.	% Changes Correct Direction
12-24 (1st period)	MOS Local	.0957 .0882	7.9	41.7 46.3	14944	8625	61.2
24-36 (2nd period)	MOS Local	.1075 .1057	1.6	36.0 37.1	14808	8358	59.8
36-48 (3rd period)	MOS Local	.1219 .1194	2.0	26.0 27.5	14922	8338	55.1

Table 2.3. Same as Table 2.2 except for 24 stations in the Eastern Region.

Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	No. of Changes to Guid.	% Changes Correct Direction
12-24 (1st period)	MOS Local	.1021 .0977	4.3	43.4 45.9	3393	2173	61.1
24-36 (2nd period)	MOS Local	.1132 .1134	-0.1	38.1 38.0	3358	1981	58.0
36-48 (3rd period)	MOS Local	.1305 .1245	4.6	26.4 29.8	3387	2031	57.2

Table 2.4. Same as Table 2.2 except for 24 stations in the Southern Region.

Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	No. of Changes to Guid.	% Changes Correct Direction
12-24 (1st period)	MOS Local	.0951 .0891	6.3	39.6 43.4	4074	2368	63.8
24-36 (2nd period)	MOS Local	.1052 .1040	1.1	34.0 34.7	3959	2354	65.1
36-48 (3rd period)	MOS Local	.1197 .1180	1.4	24.8 25.9	4064	2350	59.7

Table 2.5. Same as Table 2.2 except for 28 stations in the Central Region.

Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	No. of Changes to Guid.	% Changes Correct Direction
12-24 (1st period)	MOS Local	.0903 .0831	8.0	45.5 49.8	4681	2555	57.8
24-36 (2nd period)	MOS Local	.1054 .1044	1.0	39.0 39.6	4690	2491	57.2
36-48 (3rd period)	MOS Local	.1184 .1184	-0.0	29.4 29.4	4679	2429	48.5

Table 2.6. Same as Table 2.2 except for 17 stations in the Western Region.

Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	No. of Changes to Guid.	% Changes Correct Direction
12-24 (1st period)	MOS Local	.0979 .0837	14.5	35.3 44.6	2796	1529	63.0
24-36 (2nd period)	MOS Local	.1072 .1013	5.6	30.5 34.4	2801	1532	58.2
36-48 (3rd period)	MOS Local	.1204 .1171	2.7	21.0 23.2	2792	1528	55.8

Table 2.7. Comparative verification of MOS guidance and local PoP forecasts for 93 stations, 1200 GMT cycle.

Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	No. of Changes to Guid.	% Changes Correct Direction
12-24 (1st period)	MOS Local	.0967 .0906	6.3	42.1 45.8	14640	8524	64.6
24-36 (2nd period)	MOS Local	.1112 .1080	2.9	32.4 34.3	14773	8577	56.4
36-48 (3rd period)	MOS Local	.1242 .1212	2.4	26.1 27.9	14621	8262	61.7

Table 2.8. Same as Table 2.7 except for 24 stations in the Eastern Region.

Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	No. of Changes to Guid.	% Changes Correct Direction
12-24 (1st period)	MOS Local	.0975 .0958	1.7	46.0 46.9	3378	2030	61.7
24-36 (2nd period)	MOS Local	.1154 .1147	0.6	34.3 34.7	3410	2121	58.0
36-48 (3rd period)	MOS Local	.1307 .1275	2.4	25.8 27.6	3373	2046	62.0

Table 2.9. Same as Table 2.7 except for 24 stations in the Southern Region.

Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	No. of Changes to Guid.	% Changes Correct Direction
12-24 (1st period)	MOS Local	.0990 .0907	8.4	37.5 42.8	3871	2338	69.5
24-36 (2nd period)	MOS Local	.1118 .1078	3.6	30.0 32.5	3989	2356	56.1
36-48 (3rd period)	MOS Local	.1227 .1204	1.8	24.6 26.0	3871	2362	65.1

Table 2.10. Same as Table 2.7 except for 28 stations in the Central Region.

Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	No. of Changes to Guid.	% Changes Correct Direction
12-24 (1st period)	MOS Local	.0944 .0888	5.9	45.5 48.7	4637	2618	62.3
24-36 (2nd period)	MOS Local	.1090 .1065	2.3	35.2 36.7	4626	2567	52.6
36-48 (3rd period)	MOS Local	.1252 .1227	1.9	28.4 29.8	4634	2317	59.3

Table 2.11. Same as Table 2.7 except for 17 stations in the Western Region.

Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	No. of Changes to Guid.	% Changes Correct Direction
12-24 (1st period)	MOS Local	.0963 .0873	9.4	36.9 42.8	2754	1538	64.8
24-36 (2nd period)	MOS Local	.1089 .1026	5.7	27.9 32.0	2748	1533	60.7
36-48 (3rd period)	MOS Local	.1168 .1121	4.0	24.6 27.6	2743	1537	59.8

Table 3.1. Eighty-six stations used for comparative verification of MOS guidance and local precipitation type forecasts. These same stations, except for EWR, SDF, and TCC, were used for snow amount verification.

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DCA	Washington, D.C.	ORF	Norfolk, Virginia
PWM	Portland, Maine	CON	Concord, New Hampshire
BOS	Boston, Massachusetts	PVD	Providence, Rhode Island
ALB	Albany, New York	BTV	Burlington, Vermont
BUF	Buffalo, New York	SYR	Syracuse, New York
LGA	New York (LaGuardia), New York	EWR	Newark, New Jersey
RDU	Raleigh-Durham, North Carolina	CLT	Charlotte, North Carolina
CLE	Cleveland, Ohio	CMH	Columbus, Ohio
PHL	Philadelphia, Pennsylvania	AVP	Scranton, Pennsylvania
PIT	Pittsburgh, Pennsylvania	ERI	Erie, Pennsylvania
CAE	Columbia, South Carolina	CHS	Charleston, South Carolina
CRW	Charleston, West Virginia	BKW	Beckley, West Virginia
BHM	Birmingham, Alabama	MOB	Mobile, Alabama
LIT	Little Rock, Arkansas	FSM	Fort Smith, Arkansas
ATL	Atlanta, Georgia	SAV	Savannah, Georgia
MSY	New Orleans, Louisiana	SHV	Shreveport, Louisiana
JAN	Jackson, Mississippi	MEI	Meridian, Mississippi
ABQ	Albuquerque, New Mexico	TCC	Tucumcari, New Mexico
OKC	Oklahoma City, Oklahoma	TUL	Tulsa, Oklahoma
MEM	Memphis, Tennessee	BNA	Nashville, Tennessee
DFW	Dallas-Ft. Worth, Texas	ABI	Abilene, Texas
LBB	Lubbock, Texas	ELP	El Paso, Texas
SAT	San Antonio, Texas	IAH	Houston, Texas
DEN	Denver, Colorado	GJT	Grand Junction, Colorado
ORD	Chicago (O'Hare), Illinois	SPI	Springfield, Illinois
IND	Indianapolis, Indiana	SBN	South Bend, Indiana
DSM	Des Moines, Iowa	ALO	Waterloo, Iowa
TOP	Topeka, Kansas	ICT	Wichita, Kansas
SDF	Louisville, Kentucky	LEX	Lexington, Kentucky
DTW	Detroit, Michigan	GRR	Grand Rapids, Michigan
MSP	Minneapolis, Minnesota	DLH	Duluth, Minnesota
STL	St. Louis, Missouri	MCI	Kansas City, Missouri
OMA	Omaha, Nebraska	LBF	North Platte, Nebraska
BIS	Bismarck, North Dakota	FAR	Fargo, North Dakota
FSD	Sioux Falls, South Dakota	RAP	Rapid City, South Dakota
MKE	Milwaukee, Wisconsin	MSN	Madison, Wisconsin
CYS	Cheyenne, Wyoming	CPR	Casper, Wyoming
BOI	Boise, Idaho	PIH	Pocatello, Idaho
GTF	Great Falls, Montana	HLN	Helena, Montana
RNO	Reno, Nevada	LAS	Las Vegas, Nevada
PDX	Portland, Oregon	MFR	Medford, Oregon
SLC	Salt Lake City, Utah	CDC	Cedar City, Utah
SEA	Seattle-Tacoma, Washington	GEG	Spokane, Washington

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Table 3.2. Contingency tables for MOS guidance and local forecasts of PoPT for 86 stations, 0000 GMT cycle. Only cases where the local PoP was  $\geq 30\%$  were included.

18-h Forecasts											
Local						MOS					
	ZR	S	R	T		ZR	S	R	T		
	ZR	14	12	10	36		ZR	10	13	13	36
OBS	S	13	633	99	745	OBS	S	9	673	63	745
	R	13	34	962	1009		R	12	36	961	1009
	T	40	679	1071	1790		T	31	722	1037	1790
30-h Forecasts											
Local						MOS					
	ZR	S	R	T		ZR	S	R	T		
	ZR	15	26	11	52		ZR	21	20	11	52
OBS	S	15	613	66	694	OBS	S	32	610	52	694
	R	11	67	850	928		R	24	41	863	928
	T	41	706	927	1674		T	77	671	926	1674
42-h Forecasts											
Local						MOS					
	ZR	S	R	T		ZR	S	R	T		
	ZR	6	17	5	28		ZR	9	10	9	28
OBS	S	10	492	71	573	OBS	S	18	505	50	573
	R	9	56	778	843		R	28	49	766	843
	T	25	565	854	1444		T	55	564	825	1444

Table 3.3. Same as Table 3.2 except for the 1200 GMT cycle.

18-h Forecasts											
Local						MOS					
	ZR	S	R	T		ZR	S	R	T		
	ZR	20	26	13	59		ZR	29	19	11	59
OBS	S	23	664	72	759	OBS	S	37	663	59	759
	R	12	33	908	953		R	15	28	910	953
	T	55	723	993	1771		T	81	710	980	1771
30-h Forecasts											
Local						MOS					
	ZR	S	R	T		ZR	S	R	T		
	ZR	10	8	12	30		ZR	11	9	10	30
OBS	S	18	579	72	669	OBS	S	31	589	49	669
	R	14	56	803	873		R	31	46	796	873
	T	42	643	887	1572		T	73	644	855	1572
42-h Forecasts											
Local						MOS					
	ZR	S	R	T		ZR	S	R	T		
	ZR	10	31	8	49		ZR	20	18	11	49
OBS	S	13	502	64	579	OBS	S	33	481	65	579
	R	10	73	740	823		R	32	33	758	823
	T	33	606	812	1451		T	85	532	834	1451

Table 3.4. Comparative verification of MOS guidance and local forecasts of PoPT for 86 stations, 0000 GMT cycle. Only cases where the local PoP was  $\geq 30\%$  were included. Data for TCC were not available for the 30- and 42-h projections. The long dash (--) indicates there were no observations of freezing rain.

Projection (h)	Region (No. Stns)	Type of Forecast	Bias			Percent Correct	Skill Score	POD		FAR		Number of Cases
			ZR	S	R			ZR	S	ZR	S	
18	Eastern (24)	MOS	0.71	1.02	1.00	91.2	.832	0.24	0.93	0.67	0.09	581
		Local	0.82	0.99	1.02	90.5	.820	0.53	0.90	0.36	0.09	
	Southern (22)	MOS	0.71	0.78	1.04	94.1	.737	0.29	0.70	0.60	0.11	371
		Local	0.71	0.74	1.04	92.2	.647	0.14	0.61	0.80	0.18	
	Central (28)	MOS	1.17	0.98	1.01	91.2	.831	0.33	0.93	0.71	0.06	603
		Local	1.58	0.90	1.08	89.1	.792	0.33	0.86	0.79	0.04	
30	Eastern (24)	MOS	--	0.89	1.13	91.5	.830	--	0.87	--	0.03	235
		Local	--	0.83	1.17	86.1	.740	--	0.79	1.00	0.05	
	Southern (21)	MOS	1.21	0.97	1.01	88.0	.776	0.38	0.88	0.69	0.09	582
		Local	0.54	1.04	1.01	85.7	.729	0.25	0.87	0.54	0.16	
	Central (28)	MOS	2.67	0.79	1.00	91.9	.699	0.17	0.72	0.94	0.09	321
		Local	1.83	1.02	0.98	92.2	.721	0.33	0.84	0.82	0.18	
42	Eastern (24)	MOS	1.45	1.00	0.97	89.7	.810	0.50	0.91	0.66	0.09	582
		Local	0.68	1.02	1.01	88.5	.782	0.32	0.90	0.53	0.12	
	Southern (21)	MOS	--	0.94	1.07	87.3	.745	--	0.86	--	0.09	189
		Local	--	0.97	1.01	88.9	.778	--	0.89	1.00	0.09	
	Central (28)	MOS	1.48	0.97	1.00	89.3	.795	0.40	0.88	0.73	0.09	1674
		Local	0.79	1.02	1.00	88.3	.774	0.29	0.88	0.63	0.13	
42	Eastern (24)	MOS	1.33	1.02	0.96	88.1	.777	0.27	0.91	0.80	0.11	506
		Local	0.80	1.00	1.01	85.2	.718	0.20	0.86	0.75	0.14	
	Southern (21)	MOS	1.20	0.71	1.02	90.9	.479	0.20	0.50	0.83	0.29	274
		Local	0.40	1.04	1.01	92.7	.607	0.20	0.67	0.50	0.36	
	Central (28)	MOS	3.50	0.99	0.93	88.2	.779	0.50	0.90	0.86	0.08	484
		Local	1.38	1.00	0.99	88.2	.772	0.25	0.88	0.82	0.12	
42	Western (12)	MOS	--	0.95	1.03	87.8	.755	--	0.85	1.00	0.11	180
		Local	--	0.90	1.08	91.1	.820	--	0.86	--	0.05	
	All Stations	MOS	1.96	0.98	0.98	88.6	.778	0.32	0.88	0.84	0.10	1444
		Local	0.89	0.99	1.01	88.4	.767	0.21	0.86	0.76	0.13	

Table 3.5. Same as Table 3.4 except for 1200 GMT cycle. Data for TCC were not available for the 18- and 42-h projections.

Projection (h)	Region (No. Stns)	Type of Forecast	Bias			Percent Correct	Skill Score	POD		FAR		Number of Cases
			ZR	S	R			ZR	S	ZR	S	
18	Eastern (24)	MOS	1.38	0.94	1.03	88.8	.791	0.29	0.87	0.79	0.07	597
		Local	0.90	0.95	1.05	90.0	.810	0.38	0.88	0.58	0.07	
	Southern (21)	MOS	2.13	0.73	1.01	94.5	.790	0.75	0.73	0.65	0.00	344
		Local	1.00	0.91	1.01	93.6	.753	0.13	0.80	0.88	0.12	
	Central (28)	MOS	1.17	0.95	1.04	90.5	.825	0.55	0.89	0.53	0.06	628
		Local	0.93	0.94	1.08	87.9	.776	0.38	0.86	0.59	0.08	
Western (12)	MOS	1.00	0.96	1.06	88.6	.771	1.00	0.88	0.00	0.08	202	
	Local	1.00	1.01	0.99	89.6	.790	0.00	0.91	1.00	0.09		
	All Stations	MOS	1.37	0.94	1.03	90.5	.820	0.49	0.87	0.64	0.07	1771
		Local	0.93	0.95	1.04	89.9	.806	0.34	0.87	0.64	0.08	
30	Eastern (24)	MOS	1.44	1.01	0.96	89.1	.796	0.38	0.92	0.74	0.09	522
		Local	1.06	0.99	1.01	87.9	.772	0.44	0.89	0.59	0.10	
	Southern (22)	MOS	6.00	0.76	0.97	90.2	.578	0.00	0.61	1.00	0.20	306
		Local	1.67	0.97	1.00	91.2	.586	0.00	0.67	1.00	0.31	
	Central (28)	MOS	2.82	0.96	0.96	88.6	.787	0.45	0.89	0.84	0.07	533
		Local	1.73	0.95	1.02	87.4	.761	0.27	0.87	0.84	0.08	
Western (12)	MOS	--	0.91	1.09	86.7	.736	--	0.83	1.00	0.09	211	
	Local	--	0.92	1.08	89.1	.783	--	0.86	1.00	0.07		
	All Stations	MOS	2.43	0.96	0.98	88.8	.786	0.37	0.88	0.85	0.09	1572
		Local	1.40	0.96	1.02	88.6	.776	0.33	0.87	0.76	0.10	
42	Eastern (24)	MOS	1.70	0.96	0.97	86.8	.761	0.48	0.87	0.72	0.10	498
		Local	0.61	1.07	0.97	86.1	.741	0.17	0.90	0.71	0.16	
	Southern (21)	MOS	2.75	0.50	1.05	89.9	.551	0.00	0.47	1.00	0.06	278
		Local	2.00	0.83	1.01	90.7	.621	0.25	0.61	0.88	0.27	
	Central (28)	MOS	1.62	0.94	1.00	86.5	.754	0.43	0.86	0.74	0.09	502
		Local	0.48	1.04	1.00	82.7	.673	0.19	0.84	0.60	0.19	
Western (12)	MOS	1.00	0.91	1.10	82.7	.658	0.00	0.80	1.00	0.12	173	
	Local	1.00	1.08	0.91	90.2	.804	1.00	0.95	0.00	0.12		
	All Stations	MOS	1.73	0.92	1.01	86.8	.748	0.41	0.83	0.76	0.10	1451
		Local	0.67	1.05	0.99	86.3	.734	0.20	0.87	0.70	0.17	

Table 4.1. Contingency tables for MOS guidance and local snow amount forecasts for 83 stations for the 12-24 h projection from 0000 GMT.

MOS							Local						
		<2	2-3	4-5	≥6	T			<2	2-3	4-5	≥6	T
	<2	11554	122	33	2	11711		<2	11528	158	22	3	11711
O	2-3	80	39	9	3	131	O	2-3	81	5	4	1	131
B							B						
S	4-5	12	5	4	0	21	S	4-5	12	6	3	0	21
	≥6	7	2	5	4	18		≥6	6	4	3	5	18
	T	11653	168	51	9	11881		T	11627	213	32	9	11881

Table 4.2. Same as Table 4.1 except for the 1200 GMT cycle.

MOS							Local						
		<2	2-3	4-5	≥6	T			<2	2-3	4-5	≥6	T
	<2	11426	126	19	2	11573		<2	11378	166	24	5	11573
O	2-3	80	36	18	3	137	O	2-3	78	48	8	3	137
B							B						
S	4-5	16	11	10	5	42	S	4-5	13	16	12	1	42
	≥6	9	5	6	5	25		≥6	8	8	3	6	25
	T	11531	178	53	15	11777		T	11477	238	47	15	11777

Table 4.3. Comparative verification of MOS guidance and local forecasts of snow amount for 83 stations for 12-24 h projections.

Cycle (GMT)	Type of Forecast	Percent Correct	Skill Score	Bias		Threat Score		POD		FAR	
				>2	>4	>2	>4	>2	>4	>2	>4
0000	MOS	97.6	.287	1.34	1.54	.217	.151	0.42	0.33	0.69	0.78
	Local	97.5	.282	1.49	1.05	.201	.159	0.42	0.28	0.72	0.73
1200	MOS	97.5	.323	1.21	1.01	.282	.239	0.49	0.39	0.60	0.62
	Local	97.2	.328	1.47	0.92	.263	.206	0.51	0.33	0.65	0.65

Table 5.1. Definition of the categories used for MOS guidance, local forecasts, and surface observations of wind direction and speed.

Category	Direction (degrees)	Speed (knots)
1	340-20	< 12
2	30-60	13-17
3	70-110	18-22
4	120-150	23-27
5	160-200	28-32
6	210-240	> 33
7	250-290	---
8	300-330	---

Table 5.2. Comparative verification of MOS guidance and local surface wind forecasts for 93 stations, 0000 GMT cycle.

Fcast. Proj. (h)	Type of Fcast.	Direction			Speed										Contingency Table						No. of Cases
		Mean Abs. Error (Deg)	Skill Score	No. of Cases	Mean Abs. Error (Kts)	Mean Alg. Error (Kts)	No. of Cases	Skill Score	Percent Fcast. Correct	Threat Score ( $>27$ Kts)	Bias by Category										
											1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)	5 (No. Obs)	6 (No. Obs)					
12	MOS	20	.568	3479	3.3	0.9	3490	.402	85.6	.13	1.01	0.91	0.99	0.94	0.35	0.13	14909				
	Local	18	.611		3.0	1.3		.477	86.0	.29	0.97 (12806)	1.25 (1564)	1.06 (430)	0.57 (81)	0.80 (20)	0.13 (8)					
18	MOS	23	.509	6109	3.3	0.8	6135	.402	74.2	.11	1.03	0.91	0.95	0.96	0.69	0.44	14878				
	Local	26	.464		3.4	0.4		.371	72.8	.14	1.02 (10639)	1.07 (2938)	0.75 (1012)	0.38 (228)	0.40 (45)	0.13 (16)					
24	MOS	26	.477	4602	3.6	1.2	4631	.363	80.1	.03	1.01	1.00	0.89	0.70	0.43	0.40	14896				
	Local	29	.412		3.9	1.5		.302	75.9	.03	0.95 (12120)	1.37 (1988)	0.98 (612)	0.47 (148)	0.43 (23)	0.40 (5)					

Table 5.3. Contingency Tables for MOS guidance and local surface wind direction for 93 stations, 0000 GMT cycle.

12-h Forecasts										18-h Forecasts										24-h Forecasts												
MOS										MOS										MOS												
1	2	3	4	5	6	7	8	T	1	2	3	4	5	6	7	8	T	1	2	3	4	5	6	7	8	T						
1	299	24	6	4	6	9	10	94	452	1	386	54	13	6	9	13	27	159	667	1	301	36	8	2	9	14	27	117	514			
2	48	47	18	3	2	7	0	5	130	2	79	86	43	8	8	6	9	245	2	70	99	29	3	8	9	10	9	237				
3	6	36	92	35	7	4	5	2	187	3	5	31	138	66	29	12	13	11	305	3	16	44	116	54	17	4	6	5	262			
OBS	4	0	1	31	176	76	9	6	3	302	OBS	4	5	1	50	237	183	18	6	4	504	OBS	4	4	7	41	218	118	19	12	6	425
5	1	1	2	58	475	111	17	4	669	5	8	1	3	93	774	254	51	5	1189	5	6	6	7	106	470	139	45	12	791			
6	0	0	0	4	67	370	122	11	574	6	3	0	2	7	169	637	248	18	1084	6	9	1	3	7	92	342	186	26	666			
7	4	1	3	1	8	79	375	73	544	7	14	0	3	2	13	149	742	184	1107	7	22	2	2	1	16	116	577	163	899			
8	86	4	1	5	4	4	148	369	621	8	138	2	1	3	12	19	253	580	1008	8	124	5	4	3	6	23	209	434	808			
T	444	114	153	286	645	593	683	561	3479	T	638	175	253	422	1197	1108	1346	970	6109	T	552	200	210	394	736	666	1072	772	4602			
Local										Local										Local												
1	2	3	4	5	6	7	8	T	1	2	3	4	5	6	7	8	T	1	2	3	4	5	6	7	8	T						
1	313	40	3	3	3	11	76	452	1	365	70	19	6	11	11	18	167	667	1	277	45	9	10	11	14	27	121	514				
2	33	63	24	0	2	4	1	3	130	2	82	85	42	7	7	5	10	245	2	62	86	43	7	8	10	5	16	237				
3	4	17	116	41	3	4	1	1	187	3	11	42	124	74	30	10	6	8	305	3	13	41	92	68	34	6	2	262				
OBS	4	1	0	22	185	80	10	3	1	302	OBS	4	4	3	42	250	178	13	7	7	504	OBS	4	1	5	24	171	192	16	10	6	425
5	1	2	3	52	511	78	19	3	669	5	5	2	7	151	803	161	44	16	1189	5	9	4	7	92	470	154	41	14	791			
6	1	0	0	1	81	381	98	12	574	6	3	3	3	19	266	540	218	32	1084	6	9	5	2	6	126	294	179	45	666			
7	7	0	2	1	11	74	348	101	544	7	30	3	4	5	51	163	595	256	1107	7	41	3	2	8	34	93	457	261	899			
8	101	5	5	1	1	9	88	411	621	8	179	1	2	4	16	21	205	580	1008	8	127	12	6	4	15	32	157	455	808			
T	461	127	175	284	692	563	569	608	3479	T	679	209	243	516	1362	926	1098	1076	6109	T	539	201	185	366	890	619	882	920	4602			

Table 5.4. Contingency tables for MOS guidance and local surface wind speed forecasts for 93 stations, 0000 GMT cycle.

12-h Forecasts													18-h Forecasts													24-h Forecasts																
MOS													MOS													MOS																
1	2	3	4	5	6	T							1	2	3	4	5	6	T							1	2	3	4	5	6	T										
1 12056	671	73	6	0	0	12806	1	9473	1024	123	17	2	0	10639	1	11033	978	98	10	1	0	12120				1	11033	978	98	10	1	0	12120									
2 824	547	169	23	0	1	1564	2	1338	1174	375	47	4	0	2938	2	1053	706	202	24	3	0	1988				2	1053	706	202	24	3	0	1988									
3 94	172	137	25	2	0	430	3	155	415	341	95	5	1	1012	3	146	240	178	46	2	0	612				3	146	240	178	46	2	0	612									
OBS 4	3	27	36	14	1	0	81	OBS	4	14	63	93	42	13	3	228	OBS	4	12	58	53	20	3	2	148	4	12	58	53	20	3	2	148									
5	0	5	8	4	3	0	20		5	0	6	19	15	4	1	45		5	3	5	11	4	0	0	23		5	3	5	11	4	0	0	23								
6	0	1	2	4	1	0	8		6	1	0	6	4	3	2	16		6	0	0	4	0	1	0	5		6	0	0	4	0	1	0	5								
T 12977	1423	425	76	7	1	14909	T	10981	2682	957	220	31	7	14878	T	12247	1987	546	104	10	2	14896				T	12247	1987	546	104	10	2	14896									
Local													Local													Local																
1	2	3	4	5	6	T							1	2	3	4	5	6	T							1	2	3	4	5	6	T										
1 11799	937	70	0	0	0	12806	1	9233	1286	116	3	1	0	10639	1	10330	1588	194	7	1	0	12120				1	10330	1588	194	7	1	0	12120									
2 594	812	147	9	2	0	1564	2	1368	1301	256	12	1	0	2938	2	978	805	183	21	1	0	1988				2	978	805	183	21	1	0	1988									
3 44	186	184	16	0	0	430	3	227	467	274	39	5	0	1012	3	157	277	150	25	2	1	612				3	157	277	150	25	2	1	612									
OBS 4	4	13	45	14	5	0	81	OBS	4	29	89	89	18	2	1	228	OBS	4	23	49	58	12	5	1	148	4	23	49	58	12	5	1	148									
5	0	3	7	6	4	0	20		5	2	12	17	8	5	1	45		5	3	7	9	3	1	0	23		5	3	7	9	3	1	0	23								
6	0	0	1	1	5	1	8		6	1	1	4	6	4	0	16		6	0	1	3	1	0	5		6	0	1	3	1	0	5										
T 12441	1951	454	46	16	1	14909	T	10860	3156	756	86	18	2	14878	T	11491	2727	597	69	10	2	14896				T	11491	2727	597	69	10	2	14896									

Table 5.5. Same as Table 5.2 except for 24 stations in the Eastern Region.

Fcat. Proj. (h)	Type of Fcat.	Direction			Speed											No. of Cases	
		Mean Abs. Error (Deg)	Skill Score	No. of Cases	Mean Abs. Error (Kts)	Mean Alg. Error (Kts)	No. of Cases	Skill Score	Percent Fcst. Correct	Threat Score ( $>27$ Kts)	Bias by Category						
											1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)	5 (No. Obs)		6 (No. Obs)
12	MOS	20	.532	879	2.9	0.7	884	.399	84.3	.00	1.04	0.80	0.96	0.71	0.00	0.00	3400
	Local	19	.559		2.8	1.2		.476	84.4	.29	0.97 (2845)	1.22 (444)	0.86 (92)	0.50 (14)	1.00 (4)	0.00 (1)	
18	MOS	22	.471	1561	3.0	0.7	1565	.411	72.9	.00	1.04	0.88	0.96	1.17	2.00	0.00	3384
	Local	26	.399		3.2	0.4		.352	70.4	.00	1.04 (2312)	1.00 (798)	0.70 (235)	0.50 (36)	1.50 (2)	0.00 (1)	
24	MOS	24	.417	1014	3.3	1.2	1017	.369	82.6	.00	1.02	0.88	1.07	0.61	1.00	0.00	3406
	Local	29	.358		3.9	1.7		.301	77.5	.00	0.94 (2838)	1.36 (443)	1.16 (100)	0.57 (23)	1.00 (1)	0.00 (1)	

Table 5.6. Same as Table 5.2 except for 23 stations in the Southern Region.

Fcst. Proj. (h)	Type of Fcst.	Direction			Speed										No. of Cases		
		Mean Abs. Error (Deg)	Skill Score	No. of Cases	Mean Abs. Error (Kts)	Mean Alg. Error (Kts)	No. of Cases	Skill Score	Percent Fcst. Correct	Threat Score (>27 Kts)	Contingency Table						
											Bias by Category						
											1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)		5 (No. Obs)	6 (No. Obs)
12	MOS	22	.542	738	3.1	1.3	738	.359	89.3	1.00	1.01	0.88	0.94	1.25	1.00	*	3905
	Local	19	.635		3.0	1.6		.439	89.1	.00	0.97 (3534)	1.34 (301)	0.86 (65)	1.00 (4)	1.00 (1)	*	
18	MOS	23	.500	1572	3.2	0.9	1575	.378	76.1	.00	1.03	0.89	1.03	1.00	0.50	*	3898
	Local	25	.469		3.1	0.4		.341	74.8	.00	1.02 (2930)	1.06 (754)	0.59 (175)	0.12 (33)	0.17 (6)	*	
24	MOS	26	.504	1014	3.3	1.4	1022	.353	85.2	.00	1.01	0.97	0.90	0.88	0.00	0.00	3911
	Local	29	.409		3.7	1.9		.290	80.1	.00	0.93 (3397)	1.63 (416)	0.86 (80)	0.25 (16)	1.00 (1)	0.00 (1)	

\* This category was neither forecast nor observed.

Table 5.7. Same as Table 5.2 except for 28 stations in the Central Region.

		Direction				Speed											
Fcst. Proj. (h)	Type of Fcst.	Mean Abs. Error (Deg)	Skill Score	No. of Cases	Mean Abs. Error (Kts)	Mean Alg. Error (Kts)	No. of Cases	Contingency Table									No. of Cases
								Skill Score	Percent Fcst. Correct	Threat Score (>27 Kts)	Bias by Category						
											1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)	5 (No. Obs)	6 (No. Obs)	
12	MOS	17	.585	1494	3.4	0.7	1497	.412	80.2	.14	1.01	0.98	0.93	1.17	0.42	0.17	4654
	Local	16	.629		3.0	1.0		.480	81.0	.27	0.95 (3713)	1.27 (653)	1.12 (228)	0.52 (42)	0.75 (12)	0.17 (6)	
18	MOS	21	.544	2398	3.3	0.4	2407	.397	68.2	.16	1.04	0.95	0.92	0.96	0.54	0.36	4647
	Local	24	.494		3.4	0.1		.363	66.1	.15	1.00 (2915)	1.16 (1089)	0.84 (481)	0.36 (123)	0.29 (28)	0.00 (11)	
24	MOS	23	.512	1758	3.7	0.9	1767	.357	74.9	.04	1.02	1.02	0.79	0.75	0.25	0.33	4655
	Local	27	.443		3.9	1.2		.297	69.5	.04	0.93 (3501)	1.40 (765)	1.01 (294)	0.51 (76)	0.31 (16)	0.00 (3)	

Table 5.8. Same as Table 5.2 except for 18 stations in the Western Region.

Fcast. Proj. (h)	Type of Fcast.	Direction			Speed										No. of Cases		
		Mean Abs. Error (Deg)	Skill Score	No. of Cases	Mean Abs. Error (Kts)	Mean Alg. Error (Kts)	No. of Cases	Skill Score	Percent Fcast. Correct	Threat Score (>27 Kts)	Contingency Table						
											Bias by Category						
											1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)		5 (No. Obs)	6 (No. Obs)
12	MOS	30	.452	368	4.0	1.3	371	.365	90.5	.00	1.00	0.96	1.40	0.57	0.33	0.00	2950
	Local	27	.501		3.6	1.6		.446	91.4	.50	0.99 (2714)	1.07 (166)	1.42 (45)	0.62 (21)	0.67 (3)	0.00 (1)	
18	MOS	34	.377	578	4.7	1.9	588	.350	82.5	.09	1.02	0.93	0.90	0.75	1.00	0.75	2949
	Local	37	.380		4.6	1.4		.371	83.4	.24	1.02 (2482)	0.99 (297)	0.71 (121)	0.56 (36)	0.67 (9)	0.50 (4)	
24	MOS	34	.375	816	4.1	1.9	825	.350	78.9	.00	0.99	1.13	0.99	0.58	1.00	*	2924
	Local	35	.346		4.2	1.6		.296	78.3	.00	1.01 (2384)	1.03 (364)	0.83 (138)	0.39 (33)	0.60 (5)	** (0)	

\* This category was forecast once but was not observed.

\*\* This category was forecast twice but was not observed.

Table 5.9. Comparative verification of MOS guidance and local surface wind forecasts for 94 stations, 1200 GMT cycle.

Fcast. Proj. (h)	Type of Fcast.	Direction			Speed											No. of Cases	
		Mean Abs. Error (Deg)	Skill Score	No. of Cases	Mean Abs. Error (Kts)	Mean Alg. Error (Kts)	No. of Cases	Skill Score	Percent Fcast. Correct	Threat Score (>27 Kts)	Contingency Table						
											Bias by Category						
											1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)	5 (No. Obs)		6 (No. Obs)
12	MOS	22	.526	4782	3.3	1.1	4797	.403	81.2	.05	1.00	1.04	0.93	0.83	0.75	0.60	14922
	Local	21	.541		3.3	1.5		.417	79.4	.07	0.93 (12177)	1.40 (1962)	1.16 (613)	0.66 (145)	0.95 (20)	0.00 (5)	
18	MOS	23	.523	3609	3.6	1.2	3621	.373	83.8	.00	1.01	0.98	0.92	0.69	0.16	0.00	14765
	Local	27	.447		3.6	1.1		.336	81.8	.04	0.98 (12535)	1.22 (1654)	0.81 (437)	0.36 (117)	0.32 (19)	0.33 (3)	
24	MOS	26	.498	3253	3.7	1.3	3284	.366	84.8	.06	1.02	0.95	0.87	0.58	0.14	0.38	14781
	Local	31	.424		3.9	1.3		.327	82.5	.00	0.98 (12700)	1.26 (1540)	0.78 (427)	0.47 (85)	0.14 (21)	0.13 (8)	

Table 5.10. Contingency tables for MOS guidance and local surface wind direction for 94 stations, 1200 GMT cycle.

12-h Forecasts												18-h Forecasts												24-h Forecasts											
MOS												MOS												MOS											
1	2	3	4	5	6	7	8	T				1	2	3	4	5	6	7	8	T		1	2	3	4	5	6	7	8	T					
1	298	40	6	5	11	9	26	118	513			1	270	29	8	7	6	9	16	75	420		1	264	28	5	6	8	7	14	92	424			
2	66	99	39	3	10	5	5	14	241			2	43	49	29	6	5	2	5	4	143		2	45	39	36	7	2	8	9	10	156			
3	8	29	140	44	15	1	6	1	244			3	13	28	123	33	15	7	4	2	225		3	15	28	103	38	9	5	10	2	210			
OBS	4	4	36	241	119	18	6	2	430	OBS	4	0	0	36	162	112	6	4	0	320	OBS	4	5	2	36	121	86	14	4	3	271				
5	5	1	7	106	567	144	29	6	865			5	1	5	10	79	514	114	28	8	759		5	5	3	3	47	380	113	24	8	583			
6	1	3	2	5	96	406	203	20	736			6	3	1	2	4	72	350	132	9	573		6	4	1	0	7	57	301	113	13	496			
7	15	2	0	2	16	130	644	123	932			7	7	1	4	4	19	88	368	102	593		7	11	2	2	4	8	86	337	94	544			
8	102	2	2	3	8	24	215	465	821			8	77	7	1	2	12	8	158	311	576		8	90	4	3	6	6	12	132	316	569			
T	499	180	232	409	842	737	1134	749	4782			T	414	120	213	297	755	584	715	511	3609		T	439	107	188	236	556	546	643	538	3253			
Local												Local												Local											
1	2	3	4	5	6	7	8	T				1	2	3	4	5	6	7	8	T		1	2	3	4	5	6	7	8	T					
1	306	37	5	6	7	4	15	133	513			1	233	60	8	8	6	9	16	80	420		1	245	58	10	9	7	3	10	82	424			
2	55	121	41	1	3	3	5	12	241			2	43	44	32	9	2	4	2	7	143		2	39	43	36	15	6	2	4	11	156			
3	6	19	123	77	10	7	2	0	244			3	14	21	93	59	29	5	2	2	225		3	8	26	90	51	16	4	9	6	210			
OBS	4	4	20	212	175	11	3	3	430	OBS	4	2	2	20	151	127	11	2	5	320	OBS	4	8	1	28	106	101	15	7	5	271				
5	5	0	4	55	599	171	27	4	865			5	7	4	7	83	487	118	39	14	759		5	11	1	9	61	370	91	27	13	583			
6	2	0	0	8	100	443	163	20	736			6	5	3	2	6	92	288	150	27	573		6	6	1	3	8	84	240	124	30	496			
7	15	0	1	0	16	130	573	197	932			7	23	2	2	3	29	74	292	168	593		7	30	8	5	5	24	64	248	160	544			
8	101	2	2	3	9	18	141	545	821			8	102	6	3	4	8	15	111	327	576		8	116	12	2	10	12	11	96	310	569			
T	494	181	196	362	919	787	929	914	4782			T	429	142	167	323	780	524	614	630	3609		T	463	150	183	265	620	430	525	617	3253			

Table 5.11. Contingency tables for MOS guidance and local surface wind speed forecasts for 94 stations, 1200 GMT cycle.

12-h Forecasts													18-h Forecasts													24-h Forecasts												
MOS													MOS													MOS												
1	2	3	4	5	6	T	1	2	3	4	5	6	T	1	2	3	4	5	6	T	1	2	3	4	5	6	T											
1	11098	976	95	7	1	0	12177	1	11646	804	79	6	0	12535	1	11887	738	74	1	0	12700	1	11887	738	74	1	0	12700										
2	944	791	204	23	0	0	1962	2	878	595	158	22	1	0	1654	2	858	522	147	13	0	1540	2	858	522	147	13	0	1540									
3	128	223	200	54	6	2	613	3	119	175	111	30	2	0	437	3	128	160	115	21	1	2	427	3	128	160	115	21	1	2	427							
OBS	4	7	38	61	32	6	1	145	OBS	4	19	34	44	20	0	117	OBS	4	17	30	27	10	1	0	85	4	17	30	27	10	1	0	85					
5	0	5	10	4	1	0	20	5	2	4	10	3	0	0	19	5	3	6	7	3	1	1	21	5	3	6	7	3	1	1	21							
6	1	1	1	1	1	0	5	6	1	1	1	0	0	0	3	6	0	4	3	1	0	8	6	0	4	3	1	0	8	6	0	4	3	1	0	8		
T	12178	2034	571	121	15	3	14922	T	12665	1613	403	81	3	0	14765	T	12893	1460	373	49	3	3	14781	T	12893	1460	373	49	3	3	14781							
Local													Local													Local												
1	2	3	4	5	6	T	1	2	3	4	5	6	T	1	2	3	4	5	6	T	1	2	3	4	5	6	T											
1	10583	1466	126	2	0	0	12177	1	11343	1109	81	1	1	0	12535	1	11491	1123	83	3	0	12700	1	11491	1123	83	3	0	12700									
2	693	988	257	20	4	0	1962	2	865	632	139	17	1	0	1654	2	820	592	115	12	1	0	1540	2	820	592	115	12	1	0	1540							
3	69	256	249	34	5	0	613	3	116	215	92	13	1	0	437	3	135	175	99	15	2	1	427	3	135	175	99	15	2	1	427							
OBS	4	5	30	72	31	7	0	145	OBS	4	17	56	33	8	2	1	117	OBS	4	18	37	24	6	0	85	4	18	37	24	6	0	85						
5	1	4	6	8	1	0	20	5	3	4	8	3	1	0	19	5	5	7	7	2	0	21	5	5	7	7	2	0	21	5	5	7	7	2	0	21		
6	1	0	2	0	2	0	5	6	0	1	2	0	0	0	3	6	1	2	3	2	0	8	6	1	2	3	2	0	8	6	1	2	3	2	0	8		
T	11352	2744	712	95	19	0	14922	T	12344	2017	355	42	6	1	14765	T	12470	1936	331	40	3	1	14781	T	12470	1936	331	40	3	1	14781							

Table 5.12. Same as Table 5.9 except for 24 stations in the Eastern Region.

Feat. Proj. (h)	Type of Fcast.	Direction			Speed											No. of Cases	
		Mean Abs. Error (Deg)	Skill Score	No. of Cases	Mean Abs. Error (Kts)	Mean Alg. Error (Kts)	No. of Cases	Skill Score	Percent Fcast. Correct	Threat Score (>27 Kts)	Contingency Table						
											Bias by Category						
											1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)	5 (No. Obs)		6 (No. Obs)
12	MOS	21	.481	990	3.0	0.9	992	.444	84.8	.00	1.01	0.95	0.99	0.58	1.00	0.00	3450
	Local	21	.489		3.2	1.5		.396	80.6	.00	0.93 (2892)	1.46 (428)	0.99 (104)	0.88 (24)	1.00 (1)	0.00 (1)	
18	MOS	22	.471	870	3.1	1.0	872	.413	84.5	.00	1.02	0.84	1.10	0.67	0.00	*	3419
	Local	27	.378		3.3	1.0		.348	81.3	.00	0.99 (2868)	1.14 (445)	0.94 (78)	0.37 (27)	1.00 (1)	*	
24	MOS	24	.474	833	3.4	1.0	839	.370	83.7	.00	1.03	0.82	1.01	0.36	0.00	0.00	3444
	Local	31	.346		3.5	1.3		.350	81.1	.00	0.98 (2891)	1.21 (438)	0.82 (95)	0.64 (14)	0.00 (5)	0.00 (1)	

\* This category was neither forecast nor observed.

Table 5.13. Same as Table 5.9 except for 24 stations in the Southern Region.

Fcast. Proj. (h)	Type of Fcast.	Direction			Speed											No. of Cases	
		Mean Abs. Error (deg)	Skill Score	No. of Cases	Mean Abs. Error (Kts)	Mean Alg. Error (Kts)	No. of Cases	Skill Score	Percent Fcast. Correct	Threat Score ( $>27$ Kts)	Contingency Table						
											Bias by Category						
											1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)	5 (No. Obs)		6 (No. Obs)
12	MOS	24	.534	1096	3.2	1.3	1101	.377	84.5	.17	0.99	1.10	0.92	1.31	1.50	0.00	3974
	Local	22	.534		3.2	1.8		.418	83.2	.25	0.93 (3434)	1.53 (431)	1.20 (89)	0.69 (16)	3.00 (2)	0.00 (2)	
18	MOS	24	.549	843	3.6	1.5	845	.349	86.0	.00	0.99	1.12	0.86	0.86	0.00	*	3840
	Local	26	.505		3.4	1.2		.311	85.3	.20	0.99 (3393)	1.22 (350)	0.50 (78)	0.21 (14)	0.20 (5)	0.00 (0)	
24	MOS	28	.515	682	3.5	1.8	687	.293	88.1	1.00	1.00	1.00	0.81	0.40	0.00	**	3853
	Local	32	.423		3.6	1.9		.291	86.4	.00	0.97 (3494)	1.43 (290)	0.62 (63)	0.40 (5)	1.00 (1)	0.00 (0)	

\* This category was neither forecast nor observed.

\*\* This category was forecast once but was not observed.

Table 5.14. Same as Table 5.9 except for 28 stations in the Central Region.

Fcst. Proj. (h)	Type of Fcst.	Direction			Speed										Contingency Table						No. of Cases
		Mean Abs. Error (Deg)	Skill Score	No. of Cases	Mean Abs. Error (Kts)	Mean Alg. Error (Kts)	No. of Cases	Skill Score	Percent Fcst. Correct	Threat Score (>27 Kts)	Bias by Category										
											1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)	5 (No. Obs)	6 (No. Obs)					
12	MOS	20	.558	1879	3.3	0.9	1883	.398	76.3	.04	1.01	1.03	0.91	0.82	0.62	1.50	4609				
	Local	19	.563		3.4	1.5		.402	73.2	.05	0.89 (3483)	1.44 (753)	1.33 (282)	0.54 (76)	0.54 (13)	0.00 (2)					
18	MOS	21	.527	1495	3.6	1.1	1500	.356	78.0	.00	1.02	0.95	0.98	0.75	0.15	0.00	4612				
	Local	27	.436		3.7	1.0		.327	75.6	.00	0.97 (3642)	1.25 (682)	0.88 (216)	0.37 (57)	0.15 (13)	0.00 (2)					
24	MOS	24	.482	1404	3.7	1.2	1412	.376	79.2	.05	1.02	0.99	0.88	0.85	0.17	0.20	4601				
	Local	29	.442		3.9	1.0		.311	76.0	.00	0.98 (3668)	1.22 (647)	0.79 (223)	0.50 (46)	0.08 (12)	0.00 (5)					

Table 5.15. Same as Table 5.9 except for 18 stations in the Western Region.

Fcast. Proj. (h)	Type of Fcast.	Direction			Speed										No. of Cases		
		Mean Error (Deg)	Skill Score	No. of Cases	Mean Abs. Error (Kts)	Mean Alg. Error (Kts)	No. of Cases	Skill Score	Percent Fcast. Correct	Threat Score ( $>27$ Kts)	Contingency Table						
											Bias by Category						
											1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)		5 (No. Obs)	6 (No. Obs)
12	HOS	29	.434	817	3.8	1.3		.378	80.4	.00	0.99	1.09	0.94	0.83	0.75	*	2889
	Local	24	.514		3.4	1.2	821	.443	82.6	.00	1.00 (2368)	1.07 (350)	0.91 (138)	0.76 (29)	1.25 (4)	*	
18	HOS	31	.427	401	4.2	1.3	404	.344	89.4	.00	1.01	1.10	0.58	0.42	**	0.00	2894
	Local	34	.386		4.5	1.7		.307	87.7	.00	0.99 (2632)	1.31 (177)	0.80 (65)	0.42 (19)	*** (0)	1.00 (1)	
24	HOS	32	.429	334	4.7	1.5	346	.350	90.7	.00	1.01	1.04	0.63	0.15	0.33	0.50	2883
	Local	38	.388		4.9	1.8		.305	89.1	.00	1.00 (2647)	1.22 (165)	0.80 (46)	0.30 (20)	0.33 (3)	0.50 (2)	

\* This category was neither forecast nor observed.

\*\* This category was forecast once but was not observed.

\*\*\* This category was forecast twice but was not observed.

Table 5.16. Comparative verification of MOS guidance and local 42-h surface wind speed forecasts for 94 stations, 0000 GMT cycle.

Type of Verifying Observation	Type of Forecast	Skill Score	Percent Forecast Correct	Threat Score (>22 kt)	Bias by Category		Number of Cases
					≤22 kt	>22 kt	
1-min Avg	MOS	.261	97.4	.16	1.01	0.74	13862
	Local	.164	94.1	.10	0.97 (13577)	2.56 (285)	
+3-h Max	MOS	.206	94.9	.13	1.04	0.30	13838
	Local	.229	92.4	.16	1.00 (13132)	1.04 (706)	

Table 5.17. Same as Table 5.16 except for the 1200 GMT.

Type of Verifying Observation	Type of Forecast	Skill Score	Percent Forecast Correct	Threat Score (>22 kt)	Bias by Category		Number of Cases
					≤22 kt	>22 kt	
1-min Avg	MOS	.133	99.0	.07	1.01	0.25	13663
	Local	.127	96.0	.08	0.97 (13534)	3.88 (129)	
+3-h Max	MOS	.084	97.3	.05	1.03	0.08	13641
	Local	.175	94.9	.11	0.99 (13264)	1.32 (377)	

Table 6.1. Definitions of the cloud amount categories used for the local forecasts and observations. The MOS guidance is based on similar categories for opaque amounts only.

Category	Cloud Amount
1	CLR, -SCT -BKN, -OVC, -X
2	SCT
3	BKN
4	OVC, X

Table 6.2. Comparative verification of MOS guidance and local forecasts of four categories of cloud amount (clear, scattered, broken, and overcast) for 94 stations, 0000 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category				Percent Correct	Skill Score	Number of Cases
		1	2	3	4			
12	MOS	1.03	0.97	1.39	0.89	61.2	.431	14660
	Local	0.80	1.31	1.57	0.94	70.3	.572	
	No. Obs.	4944	1824	1474	6418			
18	MOS	0.97	0.97	1.63	0.82	54.5	.373	14776
	Local	0.62	1.47	1.95	0.77	52.2	.359	
	No. Obs.	4517	2422	2001	5836			
24	MOS	0.98	1.03	1.65	0.81	53.8	.358	14790
	Local	0.62	1.54	2.07	0.78	48.1	.304	
	No. Obs.	5056	2420	1705	5609			

Table 6.3. Same as Table 6.2 except for 24 stations in the Eastern Region.

Projection (h)	Type of Forecast	Bias by Category				Percent Correct	Skill Score	Number of Cases
		1	2	3	4			
12	MOS	0.96	1.05	1.41	0.91	60.1	.412	3307
	Local	0.82	1.14	1.50	0.93	67.8	.525	
	No. Obs.	813	451	403	1640			
18	MOS	0.90	0.96	1.65	0.87	55.1	.367	3315
	Local	0.56	1.37	2.10	0.78	52.2	.346	
	No. Obs.	835	531	455	1494			
24	MOS	0.99	1.05	1.60	0.86	57.5	.383	3325
	Local	0.59	1.77	2.22	0.81	50.5	.316	
	No. Obs.	1095	428	321	1481			

Table 6.4. Same as Table 6.2 except for 24 stations in the Southern Region.

Projection (h)	Type of Forecast	Bias by Category				Percent Correct	Skill Score	Number of Cases
		1	2	3	4			
12	MOS	0.97	0.85	1.29	1.00	61.8	.443	3936
	Local	0.74	1.38	1.56	0.94	69.2	.565	
	No. Obs.	1348	544	427	1617			
18	MOS	0.96	0.79	1.36	0.97	56.5	.407	4052
	Local	0.63	1.40	1.69	0.76	52.0	.366	
	No. Obs.	1205	762	698	1387			
24	MOS	1.00	0.93	1.39	0.88	52.9	.351	4053
	Local	0.60	1.50	1.94	0.74	45.2	.277	
	No. Obs.	1386	774	545	1348			

Table 6.5. Same as Table 6.2 except for 28 stations in the Central Region.

Projection (h)	Type of Forecast	Bias by Category				Percent Correct	Skill Score	Number of Cases
		1	2	3	4			
12	MOS	1.09	0.98	1.31	0.88	62.6	.437	4631
	Local	0.80	1.38	1.66	0.95	71.4	.580	
	No. Obs.	1678	525	377	2051			
18	MOS	1.00	1.03	1.79	0.80	55.1	.366	4625
	Local	0.55	1.65	2.25	0.82	52.5	.354	
	No. Obs.	1532	692	463	1938			
24	MOS	0.99	1.04	1.63	0.84	55.2	.364	4632
	Local	0.60	1.61	2.13	0.83	49.9	.317	
	No. Obs.	1595	698	462	1877			

Table 6.6. Same as Table 6.2 except for 18 stations in the Western Region.

Projection (h)	Type of Forecast	Bias by Category				Percent Correct	Skill Score	Number of Cases
		1	2	3	4			
12	MOS	1.09	1.09	1.60	0.74	59.1	.402	2786
	Local	0.86	1.34	1.57	0.92	73.2	.612	
	No. Obs.	1105	304	267	1110			
18	MOS	0.98	1.17	1.90	0.61	50.0	.325	2784
	Local	0.75	1.43	1.91	0.70	51.7	.355	
	No. Obs.	945	437	385	1017			
24	MOS	0.91	1.16	2.07	0.55	48.5	.313	2780
	Local	0.73	1.30	2.06	0.68	46.5	.291	
	No. Obs.	980	520	377	903			

Table 6.7. Comparative verification of MOS guidance and local forecasts of four categories of cloud amount (clear, scattered, broken, and overcast) for 94 stations, 1200 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category				Percent Correct	Skill Score	Number of Cases
		1	2	3	4			
12	MOS	0.95	1.03	1.65	0.84	56.6	.396	14644
	Local	0.78	1.21	1.59	0.93	64.5	.508	
	No. Obs.	5043	2403	1678	5520			
18	MOS	1.05	1.06	1.40	0.84	60.5	.411	14475
	Local	0.67	1.73	2.23	0.86	56.0	.385	
	No. Obs.	5767	1553	1310	5845			
24	MOS	1.08	0.97	1.32	0.87	58.4	.390	14507
	Local	0.68	1.57	2.07	0.83	52.1	.332	
	No. Obs.	4861	1805	1489	6352			

Table 6.8. Same as Table 6.7 except for 24 stations in the Eastern Region.

Projection (h)	Type of Forecast	Bias by Category				Percent Correct	Skill Score	Number of Cases
		1	2	3	4			
12	MOS	0.91	1.05	1.69	0.90	58.9	.406	3334
	Local	0.73	1.34	1.85	0.92	63.5	.480	
	No. Obs.	1116	437	322	1459			
18	MOS	1.03	1.13	1.58	0.85	61.8	.420	3298
	Local	0.65	1.85	2.56	0.83	57.0	.386	
	No. Obs.	1170	288	276	1564			
24	MOS	1.06	1.07	1.36	0.86	56.1	.364	3325
	Local	0.78	1.30	1.75	0.83	52.9	.331	
	No. Obs.	834	460	423	1608			

Table 6.9. Same as Table 6.7 except for 24 stations in the Southern Region.

Projection (h)	Type of Forecast	Bias by Category				Percent Correct	Skill Score	Number of Cases
		1	2	3	4			
12	MOS	0.97	0.97	1.47	0.86	55.7	.392	3994
	Local	0.78	1.22	1.45	0.91	64.1	.512	
	No. Obs.	1344	767	536	1347			
18	MOS	1.04	0.93	1.21	0.92	60.5	.417	3854
	Local	0.64	1.78	2.06	0.84	54.4	.376	
	No. Obs.	1567	472	396	1419			
24	MOS	1.02	0.81	1.10	1.02	60.8	.423	3872
	Local	0.68	1.55	1.94	0.83	52.5	.346	
	No. Obs.	1290	538	421	1623			

Table 6.10. Same as Table 6.7 except for 28 stations in the Central Region.

Projection (h)	Type of Forecast	Bias by Category				Percent Correct	Skill Score	Number of Cases
		1	2	3	4			
12	MOS	0.98	1.01	1.56	0.87	58.5	.409	4557
	Local	0.77	1.21	1.64	0.97	66.43	.525	
	No. Obs.	1601	695	451	1810			
18	MOS	1.09	1.11	1.27	0.84	62.1	.421	4559
	Local	0.69	1.82	2.23	0.89	57.5	.392	
	No. Obs.	1828	435	356	1940			
24	MOS	1.13	0.95	1.29	0.85	59.4	.389	4544
	Local	0.63	1.76	2.35	0.85	52.1	.327	
	No. Obs.	1636	520	372	2016			

Table 6.11. Same as Table 6.7 except for 18 stations in the Western Region.

Projection (h)	Type of Forecast	Bias by Category				Percent Correct	Skill Score	Number of Cases
		1	2	3	4			
12	MOS	0.88	1.14	1.98	0.65	52.1	.356	2759
	Local	0.85	1.09	1.53	0.90	63.2	.498	
	No. Obs.	982	504	369	904			
18	MOS	1.04	1.14	1.63	0.70	56.0	.362	2764
	Local	0.70	1.44	2.15	0.87	54.5	.372	
	No. Obs.	1202	358	282	922			
24	MOS	1.09	1.13	1.63	0.72	55.9	.356	2766
	Local	0.66	1.71	2.36	0.82	50.3	.313	
	No. Obs.	1101	287	273	1105			

Table 7.1. Definitions of the categories used for verification of persistence, local, and guidance forecasts of ceiling height and visibility.

Category	Ceiling (ft)	Visibility (mi)
1	$\leq 400$	$< 1$
2	500-900	1-2 3/4
3	1000-2900	3-6
4	$\geq 3000$	$> 6$

Table 7.2. Comparative verification of MOS guidance, persistence, and local ceiling height forecasts for 93 stations, 0000 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category				Log Score	Percent Correct	Skill Score
		1	2	3	4			
12	MOS	1.27	0.76	0.95	1.01	3.641	72.4	.382
	Local	0.82	0.87	1.12	1.00	2.103	81.8	.593
	Persistence	0.86	0.88	0.97	1.03	2.158	82.0	.587
	No. Obs.	940	970	2256	10736			
15	Local	0.52	0.75	1.21	1.02	2.778	76.0	.464
	Persistence	0.93	0.84	0.93	1.04	3.092	74.8	.431
	No. Obs.	922	1067	2428	10961			
18	MOS	1.19	0.81	1.03	1.00	2.798	74.1	.384
	Local	0.41	0.61	1.10	1.04	2.417	76.0	.401
	Persistence	1.54	1.01	0.87	1.00	3.416	71.4	.321
	No. Obs.	522	842	2509	11001			
24	MOS	1.32	0.81	0.89	1.02	2.307	79.6	.369
	Local	0.26	0.73	1.27	1.00	2.084	78.3	.348
	Persistence	2.02	1.46	1.15	0.92	3.733	70.0	.213
	No. Obs.	399	591	1912	11984			

Table 7.3. Same as Table 7.2 except for visibility, 0000 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category				Log Score	Percent Correct	Skill Score
		1	2	3	4			
12	MOS	1.51	0.94	1.13	0.96	3.231	73.2	.351
	Local	0.85	0.78	1.28	0.98	1.885	81.0	.523
	Persistence	0.84	0.82	0.90	1.04	1.773	83.4	.551
	No. Obs.	617	913	1952	11416			
15	Local	0.48	0.46	1.10	1.07	2.679	75.0	.363
	Persistence	0.87	0.62	0.86	1.08	2.876	75.1	.365
	No. Obs.	635	1265	2132	11331			
18	MOS	1.36	0.92	1.16	0.98	2.488	77.2	.328
	Local	0.41	0.41	1.05	1.05	1.974	80.4	.328
	Persistence	1.58	0.84	1.12	0.98	2.844	75.6	.275
	No. Obs.	328	887	1570	12065			
24	MOS	1.08	0.89	1.11	0.99	1.947	81.5	.332
	Local	0.20	0.45	1.04	1.04	1.669	82.9	.302
	Persistence	2.25	1.08	1.29	0.94	2.963	75.0	.199
	No. Obs.	232	689	1361	12592			

Table 7.4. Same as Table 7.2 except for ceiling height for 94 stations, 1200 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category				Log Score	Percent Correct	Skill Score
		1	2	3	4			
12	MOS	1.33	0.83	0.97	1.00	2.264	79.8	.391
	Local	0.69	0.90	1.23	0.98	1.315	86.0	.590
	Persistence	0.96	1.09	1.19	0.97	1.441	85.1	.574
	No. Obs.	413	601	1884	12048			
15	Local	0.62	0.95	1.24	0.98	1.834	81.5	.484
	Persistence	0.79	1.04	1.16	0.98	2.102	79.8	.435
	No. Obs.	518	657	1970	12193			
18	MOS	1.54	0.67	0.90	1.01	3.196	75.1	.345
	Local	0.66	0.92	1.31	0.97	2.476	77.1	.424
	Persistence	0.64	0.80	1.12	1.01	2.718	75.6	.352
	No. Obs.	610	805	1990	11379			
24	MOS	1.55	0.72	0.88	1.00	4.257	70.2	.348
	Local	0.61	1.01	1.30	0.97	3.579	70.4	.365
	Persistence	0.40	0.67	0.98	1.09	3.995	68.3	.236
	No. Obs.	972	970	2267	10602			

Table 7.5. Same as Table 7.2 except for visibility for 94 stations, 1200 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category				Log Score	Percent Correct	Skill Score
		1	2	3	4			
12	MOS	1.26	0.80	1.05	1.00	1.837	82.8	.365
	Local	0.80	0.66	1.31	0.99	1.163	87.4	.545
	Persistence	1.00	1.10	1.01	0.99	1.242	87.5	.549
	No. Obs.	236	700	1348	12663			
15	Local	0.76	0.78	1.37	0.97	1.513	84.2	.444
	Persistence	0.88	1.29	0.99	0.99	1.714	83.8	.411
	No. Obs.	276	617	1420	12998			
18	MOS	1.55	0.77	1.05	0.99	2.475	78.9	.321
	Local	0.83	0.82	1.38	0.97	2.038	79.9	.380
	Persistence	0.68	1.16	0.86	1.02	2.166	80.4	.333
	No. Obs.	345	657	1572	12190			
24	MOS	1.74	0.86	1.03	0.96	3.709	71.1	.303
	Local	0.70	0.93	1.34	0.96	3.075	72.3	.325
	Persistence	0.37	0.82	0.70	1.10	3.332	72.5	.198
	No. Obs.	636	930	1949	11285			

Table 8.1. Verification of MOS guidance and local max/min temperature forecasts for 93 stations, 0000 GMT cycle.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Today's Max	MOS		1.3	3.8	4.3	--	--
	Local	14812	0.3	3.2	2.2	--	--
Tonight's Min	MOS		-2.3	5.0	10.0	0.70	0.51
	Local	14550	-0.7	4.1	4.9	0.67	0.34
Tomorrow's Max	MOS		0.6	4.5	7.4	--	--
	Local	14783	-0.2	4.3	6.4	--	--
Tomorrow Night's Min	MOS		-2.6	5.9	15.1	0.72	0.58
	Local	14466	-1.6	5.2	11.8	0.66	0.50

Table 8.2. Same as Table 8.1 except for 24 stations in the Eastern Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Today's Max	MOS Local	3425	1.1	3.8	4.1	--	--
			0.1	3.4	2.7	--	--
Tonight's Min	MOS Local	3254	-2.4	5.2	10.7	0.74	0.40
			-0.6	4.2	4.6	0.74	0.24
Tomorrow's Max	MOS Local	3424	0.3	4.5	6.6	--	--
			-0.6	4.5	6.7	--	--
Tomorrow Night's Min	MOS Local	3252	-2.6	6.0	15.6	0.76	0.52
			-1.6	5.4	12.5	0.67	0.46

Table 8.3. Same as Table 8.1 except for 24 stations in the Southern Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Today's Max	MOS Local	3951	1.3	3.9	4.7	--	--
			0.4	3.2	2.1	--	--
Tonight's Min	MOS Local	3934	-2.2	4.8	8.9	0.61	0.57
			-0.7	3.8	3.8	0.59	0.39
Tomorrow's Max	MOS Local	3939	0.8	4.5	7.7	--	--
			-0.0	4.2	7.0	--	--
Tomorrow Night's Min	MOS Local	3906	-2.8	5.8	14.8	0.68	0.60
			-1.8	5.0	10.6	0.61	0.52

Table 8.4. Same as Table 8.1 except for 28 stations in the Central Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Today's Max	MOS	4664	1.6	4.0	4.8	--	--
	Local		0.4	3.3	2.1	--	--
Tonight's Min	MOS	4621	-2.9	5.5	12.4	0.71	0.53
	Local		-1.0	4.4	6.3	0.68	0.38
Tomorrow's Max	MOS	4651	0.5	4.7	8.2	--	--
	Local		-0.5	4.4	6.4	--	--
Tomorrow Night's Min	MOS	4584	-3.3	6.3	18.2	0.75	0.60
	Local		-2.1	5.7	14.5	0.70	0.51

Table 8.5. Same as Table 8.1 except for 17 stations in the Western Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Today's Max	MOS	2772	0.9	3.3	2.8	--	--
	Local		0.3	2.9	1.4	--	--
Tonight's Min	MOS	2741	-1.4	4.3	6.6	0.78	0.59
	Local		-0.6	3.8	4.2	0.67	0.45
Tomorrow's Max	MOS	2769	1.1	4.2	6.6	--	--
	Local		0.4	3.9	5.0	--	--
Tomorrow Night's Min	MOS	2724	-1.1	5.0	9.9	0.64	0.63
	Local		-0.6	4.7	8.8	0.61	0.53

Table 8.6. Verification of MOS guidance and local max/min temperature forecasts for 93 stations, 1200 GMT cycle.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Tonight's Min	MOS Local	14500	-2.5 -1.0	4.8 3.6	8.9 3.0	0.69 0.68	0.47 0.31
Tomorrow's Max	MOS Local	14705	1.0 -0.2	4.3 3.9	6.5 4.6	-- --	-- --
Tomorrow Night's Min	MOS Local	14450	-2.4 -1.1	5.5 4.7	13.5 8.3	0.70 0.63	0.53 0.43
Day After Tomorrow's Max	MOS Local	14657	0.4 -0.3	5.0 4.8	10.2 8.9	-- --	-- --

Table 8.7. Same as Table 8.6 except for 24 stations in the Eastern Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Tonight's Min	MOS	3302	-2.6	5.1	10.0	0.73	0.44
	Local		-1.0	3.8	3.0	0.70	0.28
Tomorrow's Max	MOS	3462	0.5	4.2	5.1	--	--
	Local		-0.7	4.0	4.8	--	--
Tomorrow Night's Min	MOS	3288	-2.4	5.6	13.0	0.72	0.46
	Local		-1.0	4.8	7.6	0.68	0.37
Day After Tomorrow's Max	MOS	3460	-0.3	4.9	8.2	--	--
	Local		-0.9	4.8	8.4	--	--

Table 8.8. Same as Table 8.6 except for 24 stations in the Southern Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Tonight's Min	MOS	3878	-2.5	4.5	7.4	0.57	0.51
	Local		-1.0	3.3	2.1	0.65	0.38
Tomorrow's Max	MOS	3881	1.0	4.5	7.9	--	--
	Local		-0.0	3.9	4.9	--	--
Tomorrow Night's Min	MOS	3869	-2.4	5.2	12.1	0.63	0.59
	Local		-1.1	4.3	6.7	0.56	0.47
Day After Tomorrow's Max	MOS	3863	0.6	5.1	10.6	--	--
	Local		-0.1	4.9	10.2	--	--

Table 8.9. Same as Table 8.6 except for 28 stations in the Central Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Tonight's Min	MOS	4597	-3.0	5.3	11.5	0.79	0.44
	Local		-1.1	3.8	3.8	0.74	0.29
Tomorrow's Max	MOS	4619	1.2	4.5	7.4	--	--
	Local		-0.2	4.1	5.1	--	--
Tomorrow Night's Min	MOS	4579	-3.4	6.2	18.0	0.77	0.55
	Local		-1.6	5.2	10.9	0.66	0.44
Day After Tomorrow's Max	MOS	4601	0.0	5.2	11.5	--	--
	Local		-0.5	5.0	10.1	--	--

Table 8.10. Same as Table 8.6 except for 17 stations in the Western Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Tonight's Min	MOS	2723	-1.4	3.9	5.1	0.60	0.55
	Local		-0.7	3.4	2.8	0.53	0.30
Tomorrow's Max	MOS	2743	1.1	3.9	4.5	--	--
	Local		0.2	3.4	3.2	--	--
Tomorrow Night's Min	MOS	2714	-0.6	4.6	8.4	0.63	0.56
	Local		-0.5	4.3	6.8	0.63	0.50
Day After Tomorrow's Max	MOS	2733	1.9	4.8	10.2	--	--
	Local		0.6	4.2	5.9	--	--

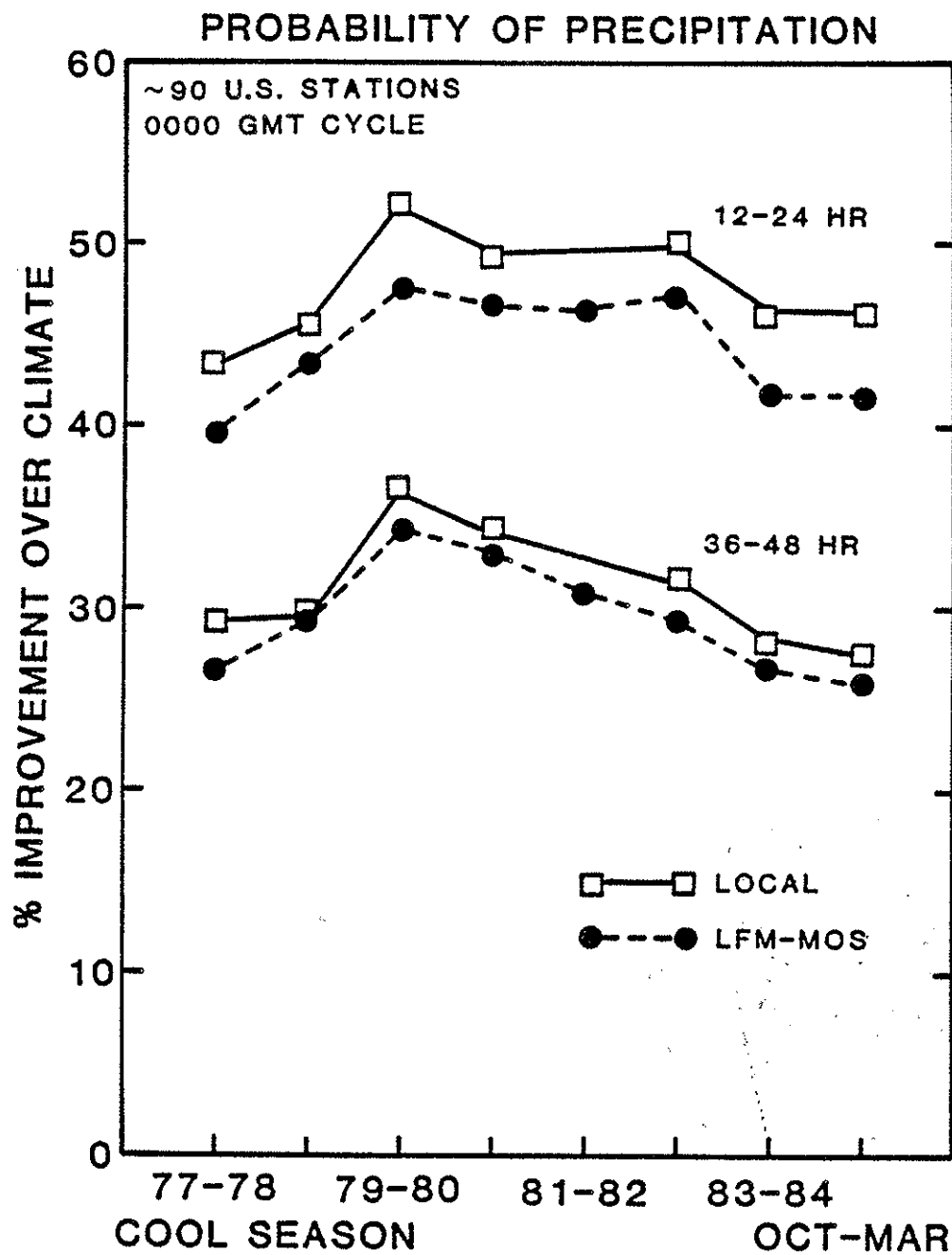


Figure 2.1. Percent improvement over climate in the Brier score of the local and guidance PoP forecasts. Results for 1981-82 local forecasts were unavailable because of missing data.

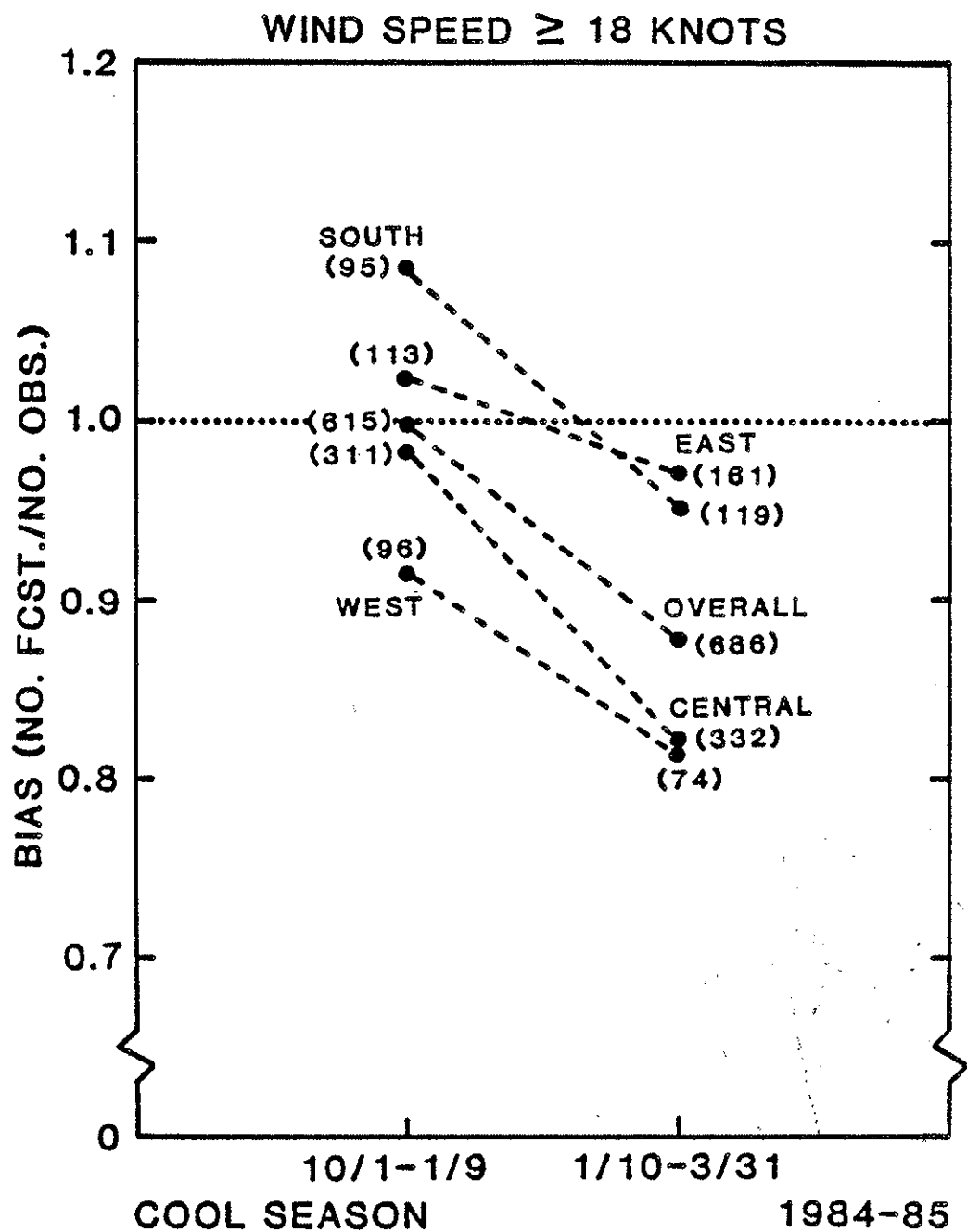


Figure 5.1. Biases for MOS surface wind speed forecasts of 18 knots or greater for the 18-h projection from 0000 GMT before and after the surface stress profile change to the LFM model. The number of observations for each sample point is given in parenthesis.